DOCUMENT RESUME

ED 371 824 PS 022 330

AUTHOR Frye-Osier, Jack
TITLE The Wisconsin Guide to Childhood Hearing Screening. Bulletin No. 94143.
INSTITUTION Wisconsin State Dept. of Public Instruction, Madison. Bureau for Exceptional Children.
PUB DATE 93
NOTE 63p.
AVAILABLE FROM Bureau for Exceptional Children, Wisconsin Department of Public Instruction, 125 South Webster Street, P.O. Box 7841, Madison, WI 53707-7841.
PUB TYPE Guides - Non-Classroom Use (055)

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS Auditory Tests; *Disability Identification; Early Childhood Education; *Early Intervention; Federal Regulation; Government Role; *Hearing Impairments; Hearing Therapy; Parent Role; *Screening Tests; State Programs; Teacher Role; *Young Children
IDENTIFIERS *Wisconsin

ABSTRACT

This guidebook was developed to assist Wisconsin parents, educators, and other professionals who deal with young children in the early identification of hearing problems. Section 1 provides an overview of the topic and discusses the importance of early identification and treatment of hearing problems. Section 2 examines state and federal laws, regulations, and programs that require, facilitate, or encourage the identification of hearing loss in infants, toddlers, and children. Section 3 addresses significant hearing screening issues and the elements of an effective screening program. Section 4 provides descriptions of specific screening tests, test protocols, and referral guidelines. Section 5 discusses the problem of unresponsive children and children who are difficult to screen, outlining strategies to include these children in screening programs. It also summarizes the main themes of the guide. Section 6 consists of five appendixes, providing copies of an American Speech-Language-Hearing Association statement on infant hearing, a list of resources for parents and caregivers, a sample home conditioning program, a glossary, and a list of relevant materials. (MDM)

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The Wisconsin Guide to Childhood Hearing Screening

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Bulletin No. 94143

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Printed on Recycled Paper

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Foreword

The normal development of children's language and communication skills is a wondrous process that occurs during the early years of life and provides the foundation for learning, socialization, and full participation in our communities. All of us entrusted with the well-being and education of our children must be vigilant to identify, early in their lives, threats to normal development of language and communication skills and to minimize them. Unidentified hearing loss in infancy and early childhood poses such a threat to thousands of Wisconsin children. Minimizing this threat will require many in the community to share responsibility and to collaborate. Hospitals, public and private health care providers, Birth to Three Programs, nursery schools, Head Start programs, day care centers, and schools all have a role to play.

The Wisconsin Department of Public Instruction developed this guide in collaboration with the Wisconsin Department of Health and Social Services. Its purpose is to help agencies and individuals in our communities entrusted with the health, education, and welfare of our children to close the gap between what we know about identifying hearing disabilities early in life and what we currently do. The state developed this guide with formal input from representatives of the public schools, public and private health care providers, Head Start and Birth to Three programs, provider professional organizations, and the deaf and hard of hearing community. The information in this guide reflects a wide consensus and describes current best practices for identifying hearing disabilities as early in life as possible.

This country's national education goal of ensuring that all children start school ready to learn by the year 2000 cannot be fully met until hearing screening programs implement practices that guarantee the early identification of hearing disabilities. Communities must recognize the importance of this issue and collaborate to get the job done. Communication among responsible agencies, programs, providers and families, which is grounded in a common information base, is essential to success. This guide provides that common information base.

John T. Benson
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Acknowledgments

The Department of Public Instruction wishes to recognize and thank the many people who assisted with the development of this publication.

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Overview

The Issue

For most children, hearing is the primary sensory channel in the complex multisensory, cognitive, and motor process through which speech and language skills are normally learned, and human communication normally develops. This process seems to proceed effortlessly during the early years of life providing the child with the basic skills necessary for successful communication and academic and psycho-social development. Many children, however, experience temporary or permanent loss of hearing that, if undetected or inappropriately managed, may interfere with the normal development of language and communication, academic success, and social-emotional well being.

The developmental consequences of hearing loss are greatest during the critical early months and years of life when language and communication skills are learned (Downs, 1986). It has long been understood that the first three to four years of life are a very important period for the development of language skills. During this period, the infant is highly receptive to the sensory, motor, and cognitive experiences on which language learning is based. Infants with normal hearing learn language as an auditory code: they repeatedly experience pairings of speech sounds with objects, events, and emotions. When disruptions in auditory reception occur in early infancy, prompt and sustained interventions are necessary to restore the stability and full utility of the auditory experience. For infants whose auditory system impairment is so severe that auditory language learning is not possible, early identification is essential to provide timely language interventions, based on visual and/or tactile encoding strategies.

The numbers of infants and children with hearing loss are surprisingly high. While prevalence estimates vary (Adams and Hardy, 1989; Berg, 1986; Lundeen, 1991; and Ross and Giolas, 1978), it is likely that at least three percent of children in the kindergarten through grade 12 population have significant hearing impairments. Included in this number are children with unilateral and bilateral hearing loss, those with permanent impairments, and those with fluctuating hearing losses due to chronic or recurrent middle ear disease. When one examines the statistics for specific groups of children, the numbers are considerably higher. For example, 12 percent of the general pediatric population have chronic or recurrent otitis media and the resultant hearing impairment. Most of these cases occur during the first three years of life when one in three children have three or more episodes of this disease. (Bluestone, et al., 1986)

Up to 50 percent of children with cognitive disabilities have been found with significant hearing loss (Kropka and Williams, 1986), and within that population, at least seven in ten children with Down Syndrome are known to have significant hearing loss. (Dahle and McCollister 1986; Davies, 1988; and Kile, et al., 1990) In addition, school-age children with other disabilities suffer with persistent hearing loss more than eight times as often as children in the broader population of school-age children. (MacDonald, 1988; Mielke and Huntoon, 1988; and Haasch, 1989)

The vast majority of childhood hearing loss and the conditions which lead to persistent fluctuating childhood hearing loss are present or develop during early infancy. (Marchant, et al, 1984; Downs, 1986; and Riko, et al., 1985) Valid, reliable, and cost-effective screening tools and methods exist to identify them during that period. Yet in the U.S., children with severe to profound hearing losses are typically not identified until age two, and children with lesser degrees of permanent hearing impairment are frequently not identified until at least age four. In addition, this country's health care system does not typically identify infants and preschoolers at risk for chronic or recurrent otitis media, nor does it track them for hearing loss and communicative impairments. This situation can result in the loss of auditory information that is critical for language development during the preschool years.

In Wisconsin, most hearing screening for children occurs in the school-age population and usually in the school setting. In addition to screening children for hearing loss relatively late in life, many school programs suffer from other shortcomings. Among them are inadequately trained and supervised screening personnel, lack of follow-up of children who fail the screening process, nonstandard screening tools and procedures, inadequate communication and recordkeeping systems, and inattention to the populations of school-age children most at risk for hearing loss and its consequences. (Frye-Osier and Wahlton, 1988)

The Challenge

Comprehensive community hearing screening programs for appropriate populations of children, implemented as early in life as possible, would result in the identification of most hearing impairments well before children enter school. The loss of sensory input and costly delays in rehabilitative interventions during the critical pre-school years could be prevented. Clearly there is a need to improve childhood hearing screening programs in Wisconsin.

To be successful, comprehensive hearing screening programs for infants and children must be a community effort. Physicians, public health providers, hospitals, medical clinics, nursery schools, day care centers, Head Start programs, Birth-to-Three programs, public and private schools, social service agencies, and families all must play a role and collaborate to get the job done. Successful screening programs must ensure the application of valid and reliable screening tools by well-trained and well-supervised staff. Communication systems must be developed among screening programs, families, educational systems, and health providers to build understanding and a common sense of purpose and to ensure a prompt and dependable exchange of information.

Identifying children who fail hearing screening tests and the middle ear function screening tests, however, is only the beginning. Both medical and audiologic evaluations must occur, and results must be communicated clearly to families, screeners, and educators. Families and educators must understand the developmental, communicative, and academic implications of documented hearing loss. Lastly, quality hearing screening should make certain that children's hearing is monitored during and after the medical treatment process to ensure resolution of the hearing loss or documentation of permanent or persistent temporary losses of hearing.

Who Can Benefit from This Guide

This guide is written to assist hearing screening leadership personnel throughout the community to understand and provide the elements necessary for quality, comprehensive screening services. Leadership personnel must make a commitment to state-of-the-art screening methods; well-trained and well-supervised screening personnel; effective communications with families, medical providers, and educators; accurate recordkeeping; and persistent monitoring and follow-up if screening efforts are to have value. This guide will assist program leaders in all of these areas, and should be the basis for hearing screening program planning and development.

The Plan of the Guide

This guide exists as a resource to assist communities in the identification of children with hearing impairments from birth through their public school years and to facilitate prompt and effective evaluations, treatment, and rehabilitative interventions. Section 2 of the guide acquaints the reader with state and federal laws, regulations, and programs that require, facilitate, or encourage the identification of hearing loss in infants, toddlers and children. Section 3 provides the reader with a discussion of important hearing screening issues and the elements of a screening program; profes-

sionals must carefully consider these as they establish or update their hearing screening programs. Descriptions of the specific screening tests, test protocols, and referral guidelines are included in section 4. Section 5 discusses the problem of unresponsive children and children who are difficult to screen and strategies for managing and including these children in the hearing screening program. Finally, section 5 summarizes the important themes in this guide and challenges communities to work toward the provision of quality hearing screening programs.

Most readers will find Appendix D, the glossary, an important reference tool when reading this guide. Many terms in this book are technical and describe audiological procedures or techniques. Readers should rely on the glossary when any confusion over a term's meaning or significance arises.

The guide will also assist the reader with references to relevant professional literature, sample program forms, helpful resources, and references to professional organizations which may provide useful educational and informational materials for hearing screening programs.

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State, Federal, and National Support

Professionals have learned much about the impact of unidentified hearing loss in infants and children in recent years, and there is now a strong national consensus among those in the health, communicative disorders, educational, and child development fields that hearing loss must be identified as early in life as possible. Legislation across the nation reflects the strength of this consensus: 18 states now have legislative mandates for screening for hearing loss in newborns (Welsh and Slater, 1993); and 34 states have laws or regulations that require hearing screening in specific populations of children. (Wisconsin Department of Public Instruction, 1990) Additional evidence documenting this consensus is found in the following material, which consists of a summary of national initiatives; federal and Wisconsin laws and regulations; and policies and programs that mandate, facilitate, or encourage hearing screening efforts in various populations of infants and children.

National Initiatives

The Joint Committee on Infant Hearing

For over 20 years, professional groups concerned with hearing loss in infants have collaborated nationally, which has resulted in position papers on neonatal screening. Since 1973, the Joint Committee on Infant Hearing, which consists of representatives from national medical and communicative disorders organizations, has produced three position statements detailing specific methods for identifying hearing loss in the newborn period. Each of the advocated methods from the Joint Committee includes the application of risk criteria to all infants. The most recent document, published in 1990, outlines methods that the Joint Committee recommends as the best practice in neonatal and infant hearing screening. (see Appendix A) It contains the most comprehensive list to date of the factors that place an infant at increased risk for hearing loss. These methods identify at least half of moderate and greater hearing impairments in the newborn. They are used in 15 of the 18 states that have mandated newborn hearing screening and in the five states that have nonmandatory statewide newborn hearing screening programs. (Welsch and Slater, 1993)

Healthy People 2000 Report

Another example of an organized national effort to address the need for early identification of hearing impairment is *Healthy People 2000: National Health Promotion and Disease Prevention Objectives* (U.S. Department of Health and Human Services, 1991). This report is the product of an effort, facilitated by the national government, to promote health and disease prevention. All state health departments and 300 national organizations produced a comprehensive document containing strategies and specific objectives for the year 2000 to improve national health and disease prevention. Included in the report are two objectives related to the identification of hearing loss in children. The first objective is to reduce the average age at which children with significant hearing loss are identified to no more than 12 months. The second objective is to increase to at least 80 percent, the proportion of primary care providers who routinely refer or screen infants and children for hearing impairment.

The U.S. Surgeon General's Initiative

In 1989, the Surgeon General of the United States established the goal that by the year 2000, 90 percent of all children with significant hearing impairment would be identified by 12 months of age and encouraged states to initiate neonatal screening programs based on risk registers for hearing loss.

Federal Laws, Regulations, and Programs

The Individuals with Disabilities Education Act—Part B

The federal government has addressed the importance of identifying hearing loss in the early months of life on several fronts. For example, the federal regulations that implement the law governing the provision of special education in the United States, the Individuals with Disabilities Education Act (IDEA), require local school districts to have procedures that identify children with disabilities who are in need of special education and related services. These disabilities include mental retardation, visual impairments, and hearing impairments including deafness, among others. This regulation covers infants, children, and youth from birth through age 21. In addition, the IDEA regulations require that all children being evaluated for the need for special education and related services be assessed in all areas related to the suspected disability including, if appropriate, hearing. (34 Code of Federal Regulations [CFR] 300.532)

IDEA—Part H

Part H of IDEA, also known as the Early Intervention Program for Infants and Toddlers with Disabilities, provides federal funds and program guidelines to help states plan and implement a comprehensive, coordinated, and interdisciplinary program of early intervention services for children ages birth to three who are developmentally disabled or delayed, or who have a physical or mental condition that is likely to lead to a developmental delay. The program requires that states design an identification system that may be coordinated with existing public and private efforts to find these children.

Section 504 of the Rehabilitation Act of 1973

Section 504 of the Rehabilitation Act of 1973 protects the rights of individuals with handicaps in programs and activities that receive federal financial assistance. Similar to IDEA, Subpart D, subsection 104.32 of Section 504 requires school districts to ". . . identify and locate every qualified handicapped person residing in the recipient's (school's) jurisdiction . . . ." The regulation defines a handicapped person as ". . . any person who (i) has a physical or mental impairment which substantially limits one or more major life activities; (ii) has a record of such an impairment, or (iii) is regarded as having such an impairment . . . ." (34 CFR 104.3) With respect to elementary and secondary education services, a qualified handicapped person is a child with a handicap who is in the same age group as other children who are mandated by the state to receive a free and appropriate public education.

Head Start Program Performance Standards

The Federal Head Start Program Performance Standards, 45 CFR 1304, define the standards necessary for local Head Start programs to achieve the federal Head Start goals and objectives. Compliance with the performance standards is required as a condition of federal funding. Health performance standard number three requires programs to screen children for hearing loss every two years beginning at age three. This standard includes pure-tone screening with an audiometer and encourages tympanometry screening for middle ear problems. Scheduling requirements for Head Start program screening services are defined in 45 CFR 1308.6, as are the program's responsibilities for evaluating children with a possible disability identified through screening. At the beginning of the 1993-94 program year, Head Start must provide hearing screening services to all its children no later than 45 calendar days after the start of program services in the fall or 45 days after the child enters the program. Head Start must refer all children over the age of three with a possible disability to their local school district for evaluation as soon as the need is evident. If the school district does not evaluate the child, the Head Start program is responsible for ensuring an

evaluation to determine if the child meets the Head Start specific disability eligibility criteria. 45 CFR 1308.11 includes recurrent temporary or fluctuating hearing loss caused by otitis media and lasting for a period of three months or more in the Head Start program eligibility criteria for hearing disability.

The Commission on Education of the Deaf

The Commission on Education of the Deaf (COED) was established by the Education of the Deaf Act of 1986 to study the quality of education of deaf persons. In its 1988 report to Congress and the President, the COED recommended that

> "The Department of Education, in collaboration with the Department of Health and Human Services, should issue federal guidelines to assist states in implementing improved screening procedures for each live birth. The guidelines should include the use of high risk criteria and should delineate subsequent follow-up procedures for infants and young children considered to be at risk for hearing impairments." (COED, 1988)

Proposed Federal Mandate

During the first session of the 103rd Congress, a bill was introduced in the U.S. House of Representatives which would require hearing loss testing for all newborn children in the United States. The Hearing Loss Testing Act of 1993, H.R. 419, establishes uniform standards for hearing loss testing programs and requires coverage for hearing loss testing in all insurance policies and health maintenance organization (HMO) contracts that provide any benefits for newborn children. Newborns not covered by HMOs, private insurance plans, or Medicaid would be covered for hearing loss testing by programs or grants provided by the U.S. Department of Health and Human Services.

The National Institute on Deafness and Other Communication Disorders

The National Deafness and Other Communication Disorders Act of 1988, PL 100-553, established the National Institute on Deafness and Other Communication Disorders (NIDCD) as the 13th Institute of the National Institutes of Health (NIH). The act requires that the director of NIDCD establish a multifaceted program to ". . . expand, intensify and coordinate activities of the Institute respecting disorders of hearing. . . ." (sec. 464). The act requires that the program include research activities in the area of prevention and early detection and diagnosis of hearing loss. In order to meet these requirements, the NIDCD has outlined a national strategic research plan (National Institute on Deafness and Other Communicative Disorders, 1989) that identifies ". . . improved methods for early screening and diagnosis of hearing loss in infants and young children. . ." as one of its primary goals.

In order to address this goal, in March of 1993 the NIDCD, together with the Office of Medical Applications and Research of the NIH, convened a consensus development conference, entitled "The Early Identification of Hearing Impairment in Infants and Young Children." The conference brought together specialists in communicative disorders, medicine, hearing science, neurological science, epidemiology, and health care administration with representatives of the public to study the issues involved in neonatal hearing screening and to make recommendations for best practice in that endeavor. The consensus statement that emerged from the conference included the recommendation that all newborns be screened for hearing impairment before they leave the hospital nursery. When that is not possible, universal hearing screening should occur before three months of age. This goal is made possible, according to the consensus statement, by recent technological developments that permit the measurement of transient evoked otoacoustic emissions from newborns and infants. Otoacoustic emissions are discussed in section 3 of this guide.

Wisconsin Rules, Regulations, Programs, and Initiatives

Wisconsin Special Education Law

Wisconsin Special Education Law, Subchapter V of Chapter 115 of the Wisconsin statutes, and PI 11, the rules which implement it, define a local school district's role in the identification of children who have a hearing handicap and because of it may need special education services. Each school board is required to screen ". . . each child in the school district who has not graduated from high school to determine if there is reasonable cause to believe that the child is a child with exceptional educational needs," (s. 115.80(2), Wis. Stats.) PI 11.03(1) of the Wisconsin Administra-

tive Code also states that the school board shall screen any child upon request including children below school age. While these rules do not dictate specific screening procedures for individual handicapping conditions, the intent to identify them in children of all ages is clear. Further, PI 11 requires school districts to evaluate all children referred for suspicion of exceptional educational need (EEN) as well as children identified in the district's own screening program as potentially eligible for EEN services. More information about local school district screening and evaluation services can be obtained by contacting the special education department in each school district.

The Wisconsin Birth-to-Three Early Intervention Program

Further evidence of Wisconsin's commitment to the early identification of infants and toddlers with disabilities, including those with hearing loss, is found in the state's participation in Part H of IDEA. The regulatory rules that implement the Birth to Three Program in Wisconsin require that local agencies administering the program provide services to ensure the identification of all children who may be eligible for the program, and refer children for screening or evaluation. Children with documented hearing impairment that will result in a developmental delay are eligible for the program. The regulations do not require the mass application of specific hearing screening tests to all infants and toddlers. However, local programs are required to participate in public awareness activities about disabling conditions in the birth-to-three period as well as to establish formal systems of communication between agencies and others in the community that will facilitate the referral process. Help in locating local birth-to-three programs can be obtained by calling Wisconsin First Step at 1-800-642-STEP (voice) and 1-800-282-1663 (TDD) or local county and city public health agencies.

Wisconsin Health Check Program

Additional Wisconsin support for the early identification of hearing impairment can be found in the Wisconsin Health Check Program. The Wisconsin Health Check program is Wisconsin's Early Periodic Screening Diagnosis and Treatment (EPSDT) Program. All states that accept federal reimbursement under the national Medical Assistance Program, (MAP) must have an EPSDT program. The Health Check Program provides preventative health check-ups, evaluations, and treatment services for eligible children from low-income families. Program participants must provide comprehensive health screening services, including hearing screenings, as recommended by professionals in the field. In Wisconsin, provider guidelines require hearing screening services at birth and continuing at regular intervals throughout infancy, early childhood, childhood, and adolescence These hearing screening requirements are outlined in the *Wisconsin MAP Provider Handbook* and include the following elements:

- For children ages birth to five years, otoscopic exams or tympanometric measurements for the detection of chronic or recurrent otitis media.
- For children ages birth to three years, the use of the risk register process described in Appendix A and of the Speech and Hearing Developmental Checklist illustrated in Figure 1.
- For children ages three to nine years, annual pure-tone audiometric screening, and at four-year intervals thereafter until the age 16 years.
- For children older than age eight years with excessive exposure to noise, delayed speech and language development, or first-time access to Health Check screening services, pure-tone audiometric screening.

Local Health Check services can be located by contacting local city or county public health agencies or by calling Wisconsin First Step at 1-800-642-STEP (voice) and 1-800-282-1663 (TDD).

Wisconsin Inter-Agency Newborn Hearing Screening Promotion

Since 1989, the Wisconsin Department of Public Instruction (DPI) and the Department of Health and Social Services (DHSS) have collaborated to promote neonatal hearing screening in Wisconsin hospitals. This statewide effort offers to hospital nursery administrators and personnel background information on the nature of the problem, a rationale for the screening effort, and program materials with which to implement a hospital screening program. This promotion encourages use of the 1990 Joint Committee on Infant Hearing's recommended methods for neonatal hearing screening. Recent surveys indicate that the number of Wisconsin hospitals following the Joint Committee's recommendations are growing. (Wahlton and Frye-Osier, 1992) In February 1992, the state surveyed 127 Wisconsin newborn nurseries regarding their hearing screening practices. Of the

79 hospitals responding to the survey, 34 reported screening for hearing loss using the methods recommended by the Joint Committee. In a 1991 survey, only 21 hospitals reported having a hearing screening program for newborns.

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Figure 1

Your Child's Speech and Hearing Development Checklist*

Instructions: Read each question through the child's age group and check Yes or No. Add the total number of Nos. If you obtain two or more Nos within any age level, or three or more Nos in all age groups through the child's age group, refer for audiological and communicative screening/assessment.

Check One		Hearing and Understanding	Child's Age	Talking	Check One	
Yes	No				Yes	No
		Does your child listen to speech? Does your child startle or cry at noises? Does your child awaken at loud sounds?	Birth	Does your child make pleasure sounds? When you play with your child, does he/she look at you, look away, and then look again?		
		Does your child turn to you when you speak? Does your child smile when spoken to? Does your child seem to recognize your voice and quiet down if crying?	0-3 Months	Does your child repeat the same sounds a lot (cooing, gooing)? Does your child cry differently for different needs? Does your child smile when he/she sees you?		
		Does your child respond to "no" or to changes in your tone of voice? Does your child look around for the source of new sounds, for example, the doorbell, vacuum, dog barking? Does your child notice toys that make sound?	4-6 Months	Does your child's babbling sound more speechlike with lots of different sounds, including p, b, and m? Does your child tell you (by sound or gesture) when he/she wants you to do something again? Does your child make gurgling sounds when left alone? when playing with you?		
		Does your child recognize words for common items like "cup," "shoe," "juice"? Does your child listen when spoken to?	7 Months - 1 Year	Does your child's babbling have both long and short groups of sounds such as "tata upup bibibibi"? Does your child imitate different speech sounds? Does your child use speech or noncrying sounds to get and keep your attention?		
		Can your child point to pictures in a book when they are named? Does your child point to a few body parts when asked? Can your child follow simple commands and understand simple questions ("Roll the ball," "Kiss the baby," "Where's your shoe")? Does your child listen to simple stories, songs, and rhymes?	1-2 Years	Is your child saying more and more words every month? Does your child use some 1-2 word questions ("where kitty?" "go bye-bye?" "what's that?")? Does your child put 2 words together ("more cookie," "no juice," "mommy back")? Does your child use many different consonant sounds at the beginning of words?		

Check One		Hearing and Understanding	Child's Age	Talking	Check One	
Yes	No				Yes	No
		Does your child understand differences in meaning ("go-stop"; "in-on" "big-little;" "up-down")?	2-3 Years	Does your child have a word for almost everything? Does your child use 2-3 word "sentences" to talk about and ask for things? Do you understand your child's speech most of the time? Does your child often ask for or direct your attention to objects by naming them?		
		Does your child hear you when you call from another room? Does your child hear television or radio at the same loudness level as other members of the family? Does your child answer simple "who," "what," "where," "why" questions?	3-4 Years	Does your child talk about what he/she does at school or a friend's house? Does your child say most sounds correctly except a few, like r, l, th, and s? Does your child usually talk easily without repeating syllables or words? Do people outside your family usually understand your child's speech? Does your child use a lot of sentences that have four or more words?		
			4-4 1/2 Years	Does your child's voice sound clear like other children's? Does your child use sentences that give lots of details (for example, "I have two red balls at home")? Can your child tell you a story and stick pretty much to the topic?		
		Does your child hear and understand most of what is said at home and in school? Does everyone who knows your child think he/she hears well (teacher, baby sitter, grandparents, and others)? Does your child pay attention to a story and answer simple questions about it?	4 1/2-5 Years	Does your child communicate easily with other children and adults? Does your child say all sounds correctly except maybe one or two? Does your child use the same grammar as the rest of the family?		
		TOTAL		TOTAL		

* From the brochure, "Baby Dear, Can You Hear?" published by the Wisconsin Department of Health and Social Services.

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3

Screening Principles and Program Components

The development of a new hearing screening program or the evaluation of an existing program should be based on fundamental screening principles, an understanding of the essential program elements necessary for achieving a meaningful result, and a commitment to provide them. To do otherwise may waste valuable resources, or worse, create a false sense of security among families, educators, and caregivers. The purpose of this section is to present the reader with a discussion of the basic issues and elements necessary to ensure a quality hearing screening program.

Screening Principles

Screening is the process of applying tests and measurements to large populations of individuals in order to separate those who are likely to have a specific disorder from those who are not. Screening is not a diagnostic process. It is a process that produces false positive and false negative results that are directly related to how the criteria for passing and failing are selected.

Successful screening programs require adherence to several basic principles. For example, the measures used to screen must be valid and reliable. That is, the tests must be able to identify most of those who have the disorder without falsely identifying many of those who do not. Also, no matter who administers the tests, the results must be reproducible. Specific tests are discussed in section four of this guide.

Screening personnel should base the decision to screen for a specific disorder on consideration of the following additional principles:

The occurrence of the disorder should be frequent enough or the consequences serious enough to justify the screening efforts. The reader should refer to the overview of this guide for the prevalence figures of hearing impairment when considering this principle. Most loss of hearing and conditions which lead to hearing loss are present in early infancy. Permanent childhood hearing loss that begins *after* early childhood is infrequent. Also, the prevalence of ear disease and related loss of hearing sensitivity peaks in early childhood, then gradually declines in the early elementary school years. (Bluestone, et al., 1983)

Treatment or intervention will reduce the negative consequences of the disorder. Unidentified hearing loss and/or inadequate intervention leads to predictable negative outcomes for children. (Davis, et al., 1986) Timely, appropriate interventions can reduce and sometimes eliminate most of the negative consequences of childhood hearing loss. (Northern and Downs, 1984)

All affected individuals should have access to diagnosis and treatment services. Both geography and financial ability will determine access to treatment services. In Wisconsin, all communities should have access to necessary federal, state, and local community resources which meet the diagnostic, treatment, and educational needs of children with hearing loss.

The costs of the screening process are justified by the benefits to affected individuals. The early identification, evaluation, treatment, and rehabilitation of hearing loss in infants and

children reduces the need for costly and prolonged special educational and medical services later in childhood and adolescence. (Downs, 1986) Valid, cost-effective methods of screening in newborns, infants, and children are well established and will receive more attention later in this guide.

Selecting the Population to be Screened

The onset of most significant hearing loss and the disease processes that lead to some common childhood hearing losses occur well before the age that children enter kindergarten. Therefore, if annual hearing screening were routinely conducted for all children ages birth to five years, screening in grades K-12 could be restricted to

- children known to have recurrent or chronic ear disease;
- children with other medical conditions known to be associated with hearing loss (see risk factors in Appendix A);
- children referred by teachers, parents, or others because of a concern for a hearing loss; and
- children known to be at risk for noise-induced hearing loss. (Children at risk for noise-induced hearing loss include those who habitually engage in very noisy leisure time and recreational activities and children enrolled in vocational training programs or engaged in employment activities involving loud equipment.)

Comprehensive hearing screening in all hospital nurseries, well-baby clinics, child care institutions, Head Start programs, and early intervention programs currently does not occur in most Wisconsin communities. Therefore, the need to screen in the elementary and secondary school population will continue to exist in many communities until screening programs for children from birth to age five are improved.

The populations to be screened are as follows:

- all newborns;
- all infants and children from birth to age five, annually;
- all children ages five and older in the four restricted categories listed above, when a satisfactory pre-kindergarten hearing screening history can be documented; and
- all children ages five and older for whom a satisfactory pre-kindergarten hearing screening history cannot be established.

Many children in the target populations are difficult to screen. Successful screening may require special skills, procedures, and environments. A full discussion of screening difficult-to-screen children can be found in section 5 of this guide.

Hearing Screening Personnel and Training Elements

Personnel

Screening for hearing loss in infants, toddlers, and children in high priority designated populations is often difficult. Without a solid commitment to well-trained, supervised, and experienced screening personnel, hearing screening programs cannot be successful. This is particularly true when screening requires a behavioral response from preschoolers and other children who are difficult to test. Successful screening of these children will often require that the screening be done by the most skilled and experienced screeners in the program.

The Program Director. The program director is responsibile for all aspects of the screening program and should coordinate with a local licensed audiologist to ensure that all program criteria are met in order to guarantee a quality screening program.

The Audiologist. The licensed audiologist is an essential resource and should play a part in all hearing screening programs for infants, toddlers, and children. The extent of the audiologist's involvement will vary with the population being screened, the skills and experience of others in the program, and the degree of community collaboration and consensus in the screening process. The audiologist's roles may include, but are not limited to the following:

- Consultation in the development and evaluation of the screening program.
- The development and provision of training programs for screening personnel. Training programs should include on-the-job training and supervision and the use of performance evaluation criteria for the determination of minimal competence.
- The provision of screening services for children found to be unscreenable by others.
- The provision of pure-tone threshold tests prior to medical referral for children who have failed the pure-tone screening process.

- The development of informational materials for parents, medical providers, and school personnel.
- The development of communication and record-keeping systems that ensure an uninterrupted flow of useful information among the screening program, families, medical providers, and schools.
- The calibration of audiometric equipment.

The Pure-Tone Threshold Tester. Some models for pure-tone hearing screening recommend the completion of pure-tone threshold testing prior to the medical referral. The pros and cons of this procedure will be discussed in section 4 of this guide. Pure-tone threshold testing is considerably more difficult than pure-tone screening, because threshold testing requires greater levels of skill and experience. Most personnel in hearing screening programs do not have the training, skills, and experience or the necessary test environment and equipment to complete this task successfully, especially for children who are the highest priority for screening. Therefore, if threshold testing is to be done before the medical referral is made, it should only be conducted in appropriate environments, using appropriate equipment, by a licensed audiologist, or by an experienced person trained and supervised by a licensed audiologist.

The Screener. The screener is the most important component in the hearing screening program. Without competent screening personnel, all other hearing screening program resources are wasted. Unless a commitment to well-trained, experienced, and supervised screening personnel can be made, hearing screening should not be attempted. Screening services provided by unskilled personnel are worse than no services at all, because the mere existence of a screening program implies validity in the minds of many parents and educators. Such impressions can lull parents and educators into a false sense of security and forestall actions that might otherwise identify a problem early. Conversely, the reporting of potential hearing problems where none exist can create unnecessary stress and expense for the family and can damage the credibility of the screening program.

The screener's primary responsibility is to efficiently and accurately apply appropriate screening measures to children in assigned populations. This requires a basic understanding of the screening tools, the methods for applying the tools, normal and abnormal auditory mechanisms, and the implications of hearing loss for communication and learning. Screeners involved in behavioral screening of children must also be familiar with the children's response characteristics during hearing screening. Screeners must also know how to train children for behavioral screening. These responsibilities require skills that can only be developed over time, with appropriate training and supervision. When screening programs have to recruit and retrain new screening personnel every year, the program will not work well.

Training

High quality training for hearing screening personnel is critical. Training should only be provided by someone who is knowledgeable about the minimal training elements listed below and who has extensive hearing screening experience and well-developed skills.

The licensed audiologist may be the only individual who meets these criteria for some programs. However, many programs include nurses, speech and language pathologists, and others who have the necessary skills and experiences to offer quality training and supervision for screening personnel. All hearing screening programs should engage a licensed audiologist to make a periodic consultation, observation, and program evaluation. The program director then, in collaboration with the licensed audiologist, will make the decisions about who is the most appropriate person to train and supervise hearing screening personnel.

Minimal Training Elements. The minimal training for screening will vary with the population screened. However, minimal training for all screeners should include:

- anatomy and physiology of the auditory system,
- hearing disorders and their causes,
- screening tools, methods, and procedures, and
- the consequences of hearing loss for communication and learning.

Training for Neonatal Hearing Screening. The recommended hearing screening for the newborn population is initially accomplished through visual examination of the infant and review of family and pre-, peri-, and postnatal history. Infants who are positive for one or more of the risk criteria listed in Appendix A should be referred as soon as possible for Auditory Brainstem Response (ABR) screening by or under the direct supervision of an audiologist. ABR screening procedures are discussed later in this section. In addition to the minimal training described above, training for screeners of newborns should include:

- the examination and interpretation of medical records,
- the visual examination of the infant for craniofacial anomalies associated with hearing loss (see risk criteria in Appendix A),
- interview techniques for acquiring relevant family history from family members,
- supervised experience in the above resulting in satisfactory independent performance, and
- when appropriate, completion of a supervised experience administering and scoring ABR screening tests, supervised by an audiologist and resulting in satisfactory independent performance.

Training for Screening in Infancy—First Three Years of Life. The recommended hearing screening during this period compares a child's speech and hearing behavior to children's normal development of communication skills. Tympanometry is also included in the recommended screening protocol for children in this population beginning at age seven months (corrected for prematurity). Tympanometry measures and documents certain physical characteristics of the middle ear system. In addition, given the appropriate equipment, environment, and training, Visual Reinforcement Audiometry (VRA) screening can also be accomplished. More detailed information about the procedures of tympanometry and VRA appears in section 4. Training for screeners of children in this population should include the minimal elements defined above and:
- knowledge of developmental milestones in speech and hearing,
- techniques for interviewing parents and caregivers,
- when appropriate, completion of a supervised experience administering and interpreting tympanometric tests in this population, resulting in satisfactory independent performance, and
- when appropriate, completion of a supervised experience administering and interpreting VRA behavioral hearing screening tests in this population, resulting in satisfactory independent performance.

Training for Screening Children—Ages Three to Five. Beginning at about age three, most developmentally normal children can be sufficiently trained to respond to auditory stimuli to permit audiometric pure-tone hearing screening. Pure tones are used as signals in hearing tests and are generated by an audiometer. However, successful pure-tone screening in this age group requires very skilled and experienced screeners. Therefore, the training of those who screen these children must meet high standards, because the risk of unreliable pure-tone screening results is high for this population. When attempting to screen children in this population who cannot accomplish the pure-tone screening task, screeners may use the methods employed for infants. Tympanometric screening is also recommended for children during this period. Training for screeners of these children should include the minimal elements described above plus:
- the elements described for screeners of children in the first three years of life, and
- satisfactory completion of a supervised experience conducting pure-tone screening tests (including play-conditioning techniques) for this population, resulting in satisfactory independent performance. (described in more detail in section 4)

Training for Screening in the School Age Population—Age 5 to 21. Most children in this population can be screened using audiometric pure-tone screening techniques. Those who cannot accomplish the pure-tone screening task may be screened using the methods employed for children during the first three years of life. Tympanometric screening is not recommended during this period except for some children with disabilities, including cognitive disabilities, hearing loss, severe developmental delays, severe physical handicaps, recent (within one year) histories of chronic or recurrent ear disease, and others. Therefore, training for screeners of this population should be comprehensive and include the elements described above for all children from birth to age five.

The Referral Process

When an infant or child fails the hearing screening, the process of facilitating a prompt medical evaluation should begin. When working with parents, program personnel should do the following:
- immediately notify them of the tests results;
- explain the screening process;
- emphasize that the screening results are not diagnostic, but advisory, and *suggest* the presence of a hearing loss;
- explain the need for prompt medical and hearing evaluations which will provide a diagnosis and document any hearing loss;
- explain that there are potential negative developmental consequences for the child when a hearing loss is ignored; and

- provide consultation for locating evaluation and treatment services and financial assistance, if necessary.

When working with medical providers, program personnel should do the following:

- provide complete screening information that includes the dates of the failures and the screening tests used, and
- request feedback about the evaluation results.

Parental education about the screening process and the causes and consequences of childhood hearing impairment is very important. Program personnel may find that this task is easier if they use commercially available brochures, pamphlets, and other publications. Appendix B lists organizations that publish brochures, pamphlets, and other inexpensive publications designed to educate parents and caregivers about childhood hearing loss and its causes, consequences, and treatment.

An example of a parental notification letter suitable for use in a school hearing screening program is shown in Figure 2. The letter includes the dates of the failure, encouragement to seek medical and hearing evaluations, guidance for seeking financial assistance for the evaluations, and specific requests for evaluation information.

Prompt and understandable reporting to the family and the screening program director regarding the outcome of the evaluation is critical, because a documented hearing loss requires immediate intervention. A parental notification letter can facilitate this prompt feedback, if it includes a blank reporting form for the parent or guardian to give to the physician at the time of the evaluation. Figure 3 is an example of such a form. Screening personnel should urge parents to require the physician and audiologist to complete the form and return it to them. The family then returns the form to the hearing screening coordinator. This form may be designed as a carbon copy form, so that the family, medical provider, and screening agency all have a record of the screening dates, the referral, and the evaluation findings.

No official medical release form is needed when the physician provides the results of the evaluation to the family and the family shares this information with the screening program. However, if this feedback mechanism fails, the physician could send medical evaluation information directly to the screening program *if* the family files a signed release-of-information form with the physician.

The Medical Component of the Screening Program

Hearing loss is a symptom of physiological dysfunction in the auditory system and thus is a medical issue. Therefore, even before the program produces the first medical referral, the program director should communicate the program's objectives, procedures, methods, and expectations to physicians in the community who will receive the hearing screening failure referrals. Such efforts provide opportunities for mutual education and consensus building, reduce the potential for misunderstandings and conflicting messages to parents, and create the common sense of purpose that is so important for quality community hearing screening programs for children.

The hearing screening program should promptly refer all children who fail the hearing screening process to a physician with experience in the evaluation and management of childhood ear disease and disorders. The medical component of hearing screening should be appropriately integrated with other aspects of the program.

As described earlier, the medical referral process should give the physician the dates of the screening tests, a description of the specific tests used, and the test results. When pure-tone screening is used, screening personnel need not report each frequency failed in each ear. Simply specifying which ear(s) failed the pure-tone screening is adequate. When using pure-tone threshold testing, screeners should include the specific results in the medical referral information. Similarly, when screeners use tympanometric measurements, the results should be included in the referral information. The sample form shown in Figure 4 is an efficient tool for recording and reporting screening test procedures and results when screeners conduct simultaneous pure-tone and tympanometric procedures. If a hearing loss is found, the medical report should include a description of the medical cause of the loss, the prescribed medical treatments, the predicted future stability of the hearing loss, and the need for periodic medical and audiologic monitoring.

The Audiologic Component of the Screening Program

The ultimate goal of any hearing screening program is to reduce the communication problems which are secondary to a hearing loss. Therefore, evaluations that follow screening failure should

Figure 2

Sample Parental Notification Letter

Date: _____

Dear Parent/Guardian:

Your child recently participated in the school hearing screening program and failed the screening on ___(date)_____ and ___(date)_____. These results indicate that your child MAY have a hearing loss that is medically and educationally significant.

We recommend that you have your child's ears examined by a physician and his/her hearing evaluated by an audiologist as soon as possible. Early identification and treatment of a hearing problem could prevent it from interfering with your child's learning.

If you need assistance in locating providers to complete evaluations, please contact us at the address and phone number below. We may also be able to refer you to agencies or programs which can provide financial assistance for these evaluations.

At the time of your child's evaluations, please make sure that sections A and B on the enclosed form are completed. It is very important that we receive this information. Please return the completed form to the address below so that we can update your child's school health records and inform his or her teachers about a hearing loss if it exists. If your child is already under medical care for an ear problem, please ask your physician and audiologist to complete the form.

Thank you for your cooperation. Please call if you have any questions.

Name: _____

Address: _____

_____

_____

Phone Number: _____

Figure 3

Hearing Screening Referral/Medical Evaluation

Date _____

Referring Program Street Address

Referring Program Address *City, State, ZIP*	Phone No. *Area Code*
Child's Name	Child's Birthdate *Mo./Day/Yr.*

Dear Physician:

The child named above failed the school hearing screening process on _____(date)_____. and _____(date)_____. When two successive hearing screenings are failed four to six weeks apart, we recommend that children be referred for medical and hearing evaluations.

It is very important that we learn of the results of the medical and hearing evaluations. Therefore, please return this form with sections A and B completed to the child's parent or guardian or to the above address as soon as possible. As always, your feedback is greatly appreciated.

A. Physician's Findings and Recommendations

Right	Left		(Describe Findings)
		Otitis Media	
		Otitis Externa	
		Eardrum Abnormality	
		Ear Wax	
		Other Pathology	
		No Pathology	

Recommendations:

Physician's Name *Please Print or Type*	❑ ENT ❑ PED ❑ FP
Physician's Signature ➤	Date Signed

B. Hearing Evaluation Findings (attach audiogram and tympanograms and include auditory management recommendations)

Tester's Name *Please Print or Type*	Audiologist ❑ Yes ❑ No
Tester's Signature ➤	Date Signed

include an assessment of the child's hearing by a licensed audiologist. If the audiologist finds a hearing loss, any report should clearly interpret the potential communication and learning consequences of the hearing loss and recommend procedures and strategies for auditory management.

In many Wisconsin communities, evaluations by audiologists are deferred until sometime *after* medical treatment has begun. The decision to defer hearing evaluations is often based on false assumptions, including:

- The loss of hearing sensitivity is probably minor and/or transient and does not significantly disable the child.
- The hearing loss is related to some visible and treatable pathology, and treatment will resolve it.
- The loss of auditory information during the time period required for treatment of the disease process has no developmental or learning consequences for the child.
- The hearing problem is only in one ear and, therefore, does not significantly disable the child.
- Follow-up appointments will be kept, and the hearing evaluation can be done at the next visit.
- Somebody else (the hearing screening program or the school, among others), will follow up to ensure that hearing concerns are addressed.

These assumptions are often wrong, and the decision to defer audiological evaluations for children referred for hearing screening failure can cause significant auditory deprivation for the child. Important months can lapse, during which the child's family and school are unaware of the extent of the hearing problem and important interventions may be delayed. The hearing evaluation by a licensed audiologist is an essential component in the initial evaluation of the child following a screening failure and in subsequent follow-up evaluations until a temporary hearing loss is resolved or a stable loss is documented.

Monitoring and Follow-Up Responsibilities and Procedures

Follow-up activities are a vital part of every hearing screening program. A screening program should provide follow-up hearing screening tests of children after a medical evaluation at six- to eight-week intervals until the program either clears the children medically and audiometrically or until it documents a persistent auditory problem. Individuals throughout the community share the responsibility to monitor a child's progress through screening, evaluation, intervention, and treatment.

The Responsibility to Facilitate the Process. Clearly, parents or guardians have the primary responsibility to secure the evaluation, treatment, intervention, and follow-up services for their children. For a variety of reasons, however, parents acting alone often cannot get the job done. The reasons are many:

- Family stresses and limited resources may prevent following through on screening program recommendations.
- Families may have no knowledge of available resources.
- Families may not receive accurate information from the screening program about the potential significance of the problem for their children or the appropriate steps to take to guarantee a satisfactory outcome.
- Medical providers may offer little or no guidance about appropriate nonmedical interventions.
- Communication between medical providers and screening programs may be poor, and each may furnish conflicting information to the family.
- Communication among screening programs, early intervention programs, and schools may be poor.
- Educators and early interventionists may not understand the developmental and educational implications of the disorder.
- Parents may assume that the existence of the screening program means that "someone" is following through appropriately for their child when, in fact, no one is.

The Responsibility to Provide Assistance to Families with Children from Birth to Age Three. In Wisconsin, the responsibility to assist eligible infants and toddlers from birth to age three with significant hearing impairments, and their families, lies with county birth-to-three early intervention programs. Screening programs that suspect children have hearing impairments may refer them to the County Birth-to-Three Program for evaluation. The county agency must assign a service coordinator to facilitate the child's evaluation. If the evaluation finds a "significant or progressive" hearing loss that will likely result in developmental delay, the child and the child's family are eligible for birth-to-three program services, including comprehensive services from the service coordinator. The coordinator assists the family in the development and full implementation of the individualized family service plan.

Figure 4

Data Reporting Form

Child's Name *Last, First*

Address *Street*

City | State | Zip

Birthdate *mo/day/yr* | Age | Sex *(Check one)* ❑ Male ❑ Female | Grade

School Name

Name of Parent or Guardian *Last, First*

Date of Screening *mo/day/yr* ➤ _____

- ❑ Pass Pure Tones
- ❑ Fail Pure Tones
- ❑ CNT Pure Tones
- ❑ CNT Pure Tones and Failed Speech and Hearing Developmental Checklist (Refer)
- ❑ Pass Tympanometry
- ❑ Fail Tympanometry
- ❑ Follow-up Tympanometry
- ❑ CNT Tympanometry

Date of Screening *mo/day/yr* ➤ _____

Pure Tone Rescreening

	1000HZ	2000HZ	3000HZ	4000HZ
R	20dB	20dB	20dB	25dB
L	20dB	20dB	20dB	25dB

Tested by ➤ _____

Reliability: ❑ Poor ❑ Fair ❑ Good

Recommendations

- ❑ Pass—No Further Action Required
- ❑ Refer for Otologic/Audiologic
- ❑ Tympanometric Follow-up—8 weeks
- ❑ Retest Next Year

◄ ATTACH TYMPANOGRAMS HERE ►

The Responsibility to Provide Assistance to Families with Children Ages Three and Older. The person with leadership responsibility for the hearing screening program must be prepared to provide the support necessary to empower families to act successfully on behalf of their children. Those services include

- promptly notifying families about the screening test results, including all of the informational elements identified in the "The Referral Process" discussed earlier in this section;
- checking for parental follow-through on the medical referral recommendation and assessing the family's ability to successfully complete the medical visit;
- informing the medical and audiological providers about the needed evaluation results and monitoring and facilitating their completion;
- communicating evaluation results to education and intervention programs, including formal referral of the child to the school board of residence when there is reason to believe a child may need evaluation for special education services;
- assisting families to interact successfully with educational and intervention programs;
- monitoring to ensure resolution of the hearing loss, documenting stable hearing loss, or continuing medical care, if needed; and
- recordkeeping, and encouraging schools to keep records that will facilitate efficient hearing screening in K-12 populations (see "Selecting the Population to be Screened" in this section), and providing current sensory information about children in transition between programs.

Screening Equipment

It is not within the scope of this document to compare and contrast the characteristics of equipment from various manufacturers, to list prices, or to identify equipment suppliers and repairers. Such information can be obtained readily from the audiologist who consults with the screening program or from other audiologists in the community. If screening personnel need assistance locating an audiologist in their area, they should contact their local public health office or audiologists in either the Department of Public Instruction (voice 608-267-3720, and TDD 608-267-2427) or the Department of Health and Social Services (voice 608-267-3720, and TDD 608-267-3720).

Auditory Brainstem Response Measurement Equipment

The recommended hearing screening procedure for newborn infants is the application of specific risk criteria (described in more detail in section 4 of this guide) and measurement of the auditory brainstem response (ABR) of those infants who meet one or more of the risk criteria. The ABR test measures the electrical response in the child's brain to the presentation of auditory test signals. When the purpose of the ABR test is to evaluate hearing or screen for hearing loss in the newborn population, a licensed audiologist experienced in these measurements or other appropriately trained and experienced personnel should conduct the test. ABR equipment and test procedures are so technically complex as to be beyond the scope of this guide. Interested readers are referred to the text *Handbook of Auditory Evoked Responses* by James Hall (listed in Appendix E) for a complete discussion of ABR test procedures.

Otoacoustic Emission Measurement Equipment

Another physiological phenomenon that can be measured in infants and children and which holds great promise for hearing screening and evaluation is the otoacoustic emission (OAE). OAEs are sounds measured in the ear canal that are produced by an active biomechanical process originating within the inner ear. This process enhances and amplifies the normal motions in the inner ear structures produced by external sound stimulation.

Audiologists use brief sound stimulations of the ear to evoke OAEs. They appear to be present in all normally functioning ears and are not found in ears with mild or greater hearing loss. The applicability of OAEs for hearing screening of infants and children is currently being studied. For a review of the subject of OAEs, including their potential as a hearing screening tool and the equipment necessary to record them, the reader is referred to articles by Glattke and Kujawa (1991); Lounsberry-Martin, Whitehead, and Martin, (1991); and White and Behrens (1993). Information about these materials is found in Appendix E.

Visual Reinforcement Audiometry Equipment

Licensed audiologists may behaviorally screen the hearing of developmentally normal infants who are five months or older and have adequate visual and motor skills using a conditioning technique that employs a visual reinforcement paradigm. The technique, called Visual Reinforcement Audiometry (VRA), is discussed in further detail in section 4 of this guide. If a licensed audiologist is not available, someone thoroughly trained and supervised by a licensed audiologist may conduct this behavioral screening. Auditory stimulus equipment employing standard audiometric stimuli for VRA screening should meet the requirements of the American National Standards Institute (ANSI) for wide range audiometers (ANSI, 1989). Calibration to the ANSI standards should occur at least once every year. When VRA equipment employs nonstandard acoustic stimuli, the hearing screening program should have complete acoustic descriptions of the stimulus and outlines of the annual calibration strategies.

The audiologist may conduct VRA screening using audiometric earphones, but most frequently the procedure requires testing in the sound field using calibrated loudspeakers located some distance from the child. Sound field VRA screening requires compliance with strict acoustical requirements for the test environment. Requirements for screening test environments will be discussed later in this section.

Finally, the VRA test protocol requires the use of a strategically placed visual reinforcement device that is remotely controlled by the tester. The device must be novel and highly interesting to infants and children. Visual reinforcers that are animated and out of sight until activated are most effective. (For a discussion of VRA procedures and equipment, see the listings for the following materials in Appendix E: Moore, Wilson, and Thompson, 1977; Primus, 1988; and Primus and Thompson, 1985.)

Pure-Tone Audiometer

Pure-tone audiometers are devices that generate and present single frequency tones of varying hearing levels (HL) for the purposes of testing hearing acuity and screening for hearing loss. Pure-tone audiometric individual discrete frequency screening can be successfully conducted with children who are functioning at a developmental age of at least three years. Audiometers used for pure-tone screening must meet ANSI S3.6-1989 specifications and should be calibrated annually to those specifications. Audiometers purchased for pure-tone screening purposes need not include bone conduction testing or masking capabilities. Neither are normally included in pure-tone screening, and both add significant cost to the price of an audiometer.

If pure-tone air conduction threshold testing is included in the screening protocol, the audiometer used should include narrow-band masking capabilities which meet the ANSI 1989 specifications. Annual calibration to the ANSI standards must occur. When pure-tone threshold testing occurs, the program director has the responsibility to ensure that

- testers meet the appropriate personnel standards,
- the test environment meets the necessary standards, and
- the test is conducted according to the American Speech-Language-Hearing Association's (ASHA) "Guidelines for Manual Pure-Tone Threshold Audiometry," (ASHA, April 1978)

Noise-Exclusion Devices

Standard screening pure-tone audiometers can be modified in ways that permit some attenuation of the background noise in the screening environment. For example, noise-exclusion devices that contain and fit over audiometric earphones and around the listener's external ear are available. These devices provide significant attenuation of background noise at some test frequencies, and permit valid hearing screening to occur in some environments that otherwise would be too noisy. Potential users should be cautioned, however, that some noise-exclusion devices of this type change the volume of air that is normally trapped in the ear canal under the earphone during screening. Such air volume changes may change the loudness of the test signal at the ear drum and could render the hearing screening test result invalid. In addition, these devices are too large and heavy for use with small children and can add 25 percent to the cost of the screening audiometer.

Another way to modify audiometers to permit pure-tone screening in environments that otherwise would be too noisy is to replace the standard audiometric earphones with insert earphones. These devices deliver signals to the ear canal via a small plastic tube that is held in place in the ear canal by a compressible foam ear plug similar to those used for hearing protection in noisy environ-

ments. This ear plug, when properly inserted, attenuates background noise. Correct use of the insert earphone requires practice and can be difficult with small ear canals. In addition, insert earphones can add as much as 50 percent to the cost of the screening audiometer.

Tympanometers

Tympanometry, an effective method for identifying abnormalities of the middle ear, is employed frequently in hearing screening programs for specific populations of infants and children. Tympanometers measure compliance changes in the middle ear as air pressure is varied in the ear canal, and their specifications must be in accordance with the ANSI standard on aural acoustic immitance instruments. (ANSI, 1988) Tympanometers can be designed as either clinical or screening devices. Clinical devices are generally larger, less portable, and more complex. While they allow for more user control of the measurements, they are more expensive than screening devices. Screening tympanometers are generally suitable for use in hearing screening programs as long as they meet the ANSI standard and reliably and clearly provide the following information:

- a plot of changes in the compliance of the middle ear system as pressure in the ear canal is continually varied from positive to negative values (tympanogram),
- quantification of the compliance value measured at the most compliant point on the tympanogram,
- quantification of the equivalent ear canal volume, and
- quantification of the ear canal pressure value corresponding to the most compliant point on the tympanogram.

Currently, no national standard for the calibration of tympanometers exists. Tympanometers may, however, be calibrated to the equipment manufacturer's specifications. Minimum daily equipment checks should include the use of the manufacturer's calibration cavities and comparison of current tympanograms with sample tympanograms obtained over time from an individual with no known active or past middle ear disease. Large deviations from the expected cavity measures or gross changes in key values on the sample tympanograms (in the absence of changes in middle ear health) should prompt a complete calibration of the tympanometer to manufacturer's specifications.

Programs may purchase screening tympanometers that are combined with screening audiometers in the same instrument. Equipment that integrates a tympanometer and a pure-tone audiometer can result in certain economies in screening and transportation but can also result in inconveniences. For example, if one of the devices needs to be repaired or recalibrated, both devices will be unavailable for use.

Otoscope

The use of an otoscope in hearing screening programs prior to administration of the hearing screening tests can produce prompt referrals for active ear disease and/or medically significant ear canal and ear drum abnormalities. Otoscopic examination prior to hearing screening can also reveal the presence of excessive amounts of cerumen. This is a common cause of hearing screening failure and tympanometric screening failure in children. Visualizing, examining, and detecting abnormalities of the ear canal and ear drum require training and experience and can be especially difficult with young children. Therefore, the decision to include otoscopy in the screening process should be made in conjunction with either the advice and assistance of a physician, a nurse practitioner or a physician's assistant experienced in otoscopic evaluations of the target population.

The Hearing Screening Environment

Background Noise

Excessive levels of noise in the screening environment can alter the ABR response index and will affect the sensitivity of OAE recordings. Background noise can also mask perception of the test signals used in pure-tone and VRA screening procedures with infants and children. Unless the screener carefully controls background noise levels, false positive screening results will occur. False positives must be minimized, because unnecessary medical referrals result in wasted time and money for families and loss of credibility for screening programs.

Screening personnel can verify acceptable background noise levels for pure-tone screening and VRA screening either electronically, with sound level measurement instruments, or behaviorally when sound level measuring equipment is not available. If a calibrated sound level meter with octave-band filters is available, screeners can eas-

ily determine the acoustic adequacy of a screening environment. With the octave-band filters centered on the test frequencies, the maximum permissible octave-band sound pressure level (SPL) for each test frequency is listed below for several testing procedures.

Permissible Ambient Noise Levels During

— Pure-Tone Threshold Testing with Audiometric Earphones

500 Hz ----------19.5 dB SPL
1000 Hz ----------26.5 dB SPL
2000 Hz ----------28.0 dB SPL
4000 Hz ----------34.5 dB SPL

— Pure-Tone Screening (20 dB HL at 500, 1000, and 2000 HZ, and 25 dB HL at 4000 HZ) with Audiometric Earphones

500 Hz ----------39.5 dB SPL
1000 Hz ----------46.5 dB SPL
2000 Hz ----------48.0 dB SPL
4000 Hz ----------54.5 dB SPL

— VRA Screening Without Audiometric Earphones (35 dB HL narrow band stimuli)

500 Hz ----------49.5 dB SPL
1000 Hz ----------49.0 dB SPL
2000 Hz ----------43.5 dB SPL
4000 Hz ----------44.0 dB SPL

— VRA Screening With Audiometric Earphones (35 dB HL narrow band stimuli)

500 Hz ----------54.5 dB SPL
1000 Hz ----------61.5 dB SPL
2000 Hz ----------63.0 dB SPL
4000 Hz ----------69.5 dB SPL

VRA screening often employs speech stimuli because speech is a particularly interesting stimulus for infants and toddlers. Screening with speech stimuli can be accomplished either with or without earphones, and each test condition requires acceptable background noise levels.

Permissible Ambient Noise Levels During

— VRA Screening without Audiometric Earphones (25 dB HL speech stimulus)

500 Hz ----------39.5 dB SPL
1000 Hz ----------39.0 dB SPL
2000 Hz ----------33.5 dB SPL
4000 Hz ----------34.0 dB SPL

— VRA Screening with Audiometric Earphones (25 dB HL speech stimulus)

500 Hz ----------44.5 dB SPL
1000 Hz ----------51.5 dB SPL
2000 Hz ----------53.0 dB SPL
4000 Hz ----------59.5 dB SPL

If sound-level measuring equipment is not available, behavioral standards may be applied to estimate the acoustic adequacy of the room. Any environment in which the screening test signals can be easily heard every time they are presented is acoustically adequate. The program director must exercise caution to ensure that the person listening to the test signals has normal or near normal hearing. Otherwise, acoustically adequate screening environments may be incorrectly eliminated. Screening must not be conducted if any of the criteria above are not met. **The criterion HLs for pure-tone or VRA screening should never be increased because of excessive background noise.**

(For a discussion of the background noise requirements for ABR screening, the reader is referred to the chapter by Michael Gorga in Jacobson's *The Auditory Brainstem Response*. Concerns about background noise in OAE testing are discussed in a 1991 article by Glattke and Kujawa. Both are listed in Appendix E.)

Visual Distractions

Successful completion of a behavioral screening task requires that the child being tested focus on the task. Many children, especially young children, will have difficulty paying attention to the task if interesting visual distractions are present in the screening environment. To improve the chances for success, face the child away from or cover windows that look out on any possible distractions. Avoid screening in the presence of other children; if this is unavoidable, face the child away from any peers. If using play-conditioned audiometry, allow the child to handle only the toys necessary for screening. Behavioral pure-tone hearing screening of young children can be successful and fun for both the screener and the child, especially when the best conditions exist for focusing the child's attention on the task.

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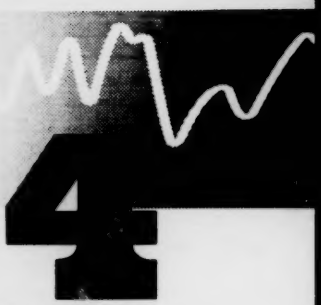

Test Protocols and Pass/Fail Referral Criteria

Recommended Procedures—Newborn Hearing Screening

Studies show that when hearing screening programs apply the risk criteria for hearing impairment recommended by the Joint Committee on Infant Hearing in 1982 to all newborns, seven to 12 percent will be found to be at greatly increased risk for hearing loss. (ASHA, 1989) If Wisconsin had applied these risk criteria to the 71,872 children born in Wisconsin in 1991, 5,000 to 9,000 children would have been identified with prenatal, perinatal, or family histories that place them at much greater risk for serious hearing impairment than other children. If an aggressive statewide program had been in place, most of the affected children in this high risk population would have been identified before their first birthday. Children without the benefit of such a program probably will not be identified until after their second birthday.

How many of the 5,000 to 9,000 infants at risk born in Wisconsin in 1991 could be expected to have significant sensory neural hearing loss? Moderate to severe sensorineural hearing loss has been confirmed in two to four percent of newborns manifesting any of the risk criteria in the 1982 list. (ASHA, 1989) Therefore, between 100 and 360 infants in this "high risk" population have moderate or greater sensorineural hearing loss. This data reveals that, of all the infants born in Wisconsin in 1991, one in every 200 to one in every 719 has serious sensorineural hearing loss.

While the 1982 risk criteria procedures will not identify all newborns (often referred to as "neonates") with serious sensorineural hearing loss, longitudinal studies have shown that from 50 to 75 percent of all infants born with moderate or greater hearing loss could be identified using the 1982 Joint Committee protocol. (Elssman, Matkin, and Sabo, 1987; Feinmesser and Tell, 1976; and Stein, Clark, and Kraus, 1983) In 1990, the Joint Committee on Infant Hearing expanded the 1982 risk criteria list for newborns, and added a set of risk factors for infants ages 29 days to two years (see Appendix A). This expanded list of criteria will increase the number of newborns and infants referred for formal hearing screening, and therefore, the sensitivity of this screening method should improve.

The Joint Committee recommends that all newborns and infants found to have met one or more of the risk criteria be referred as soon as possible for formal ABR screening and, when appropriate, behavioral (VRA) screening by or under the supervision of an audiologist. The risk criteria are listed in Appendix A for both newborns and infants.

When the screening process identifies a child with a hearing impairment, early intervention services should be offered to the child's family in accordance with Part H of IDEA and Chapter HSS 90 of the Wisconsin Administrative Code. All infants failing the screening process should be evaluated by an audiologist and a physician who specializes in diseases of the ear.

Recommended Procedures—Hearing Screening of Infants and Toddlers, Ages 29 Days to Three Years

Joint Committee on Infant Hearing Criteria

All children in this age group should be screened using both sets of risk criteria described in the Joint Committee on Infant Hearing 1990 Position Statement. (See Appendix A.) Screeners should not rule out hearing loss even if a child passes both risk screening procedures, because data have shown that the risk register identifies only from 50 to 75 percent of infants with serious sensorineural hearing loss. (Elssman, Matkin, and Sabo, 1987; Feinmesser and Tell, 1976; and Stein, Clark, and Kraus, 1983) In addition, screeners should not conclude that an infant found to be at risk for hearing loss who passes a formal hearing screening test need not be screened again. Some of the listed risk factors are associated with delayed onset hearing loss, including family history of delayed onset childhood sensorineural loss, certain congenital infections, bacterial meningitis, and prolonged mechanical ventilation in the newborn period. Finally, the Joint Committee's methods were not designed to address the problem of chronic or recurrent ear disease and concurrent conductive hearing loss in infants, toddlers, and children.

Therefore, in addition to the application of the methods described in the 1990 Joint Committee Position Statement, all infants and toddlers need screening that uses the developmental milestone method, and tympanometry. Both of these methods are described in detail below. VRA screening techniques are also appropriate for this population but require specialized equipment, test environments, and well-trained and experienced screening personnel. So, although a description of the VRA screening protocol appears below, programs should only consider it as a part of the screening battery for this population by programs that are prepared to meet the equipment, test environment, and personnel requirements for this procedure (see section 3 of this guide).

Speech and Hearing Developmental Milestones

An important additional screening tool for infants and toddlers is the Speech and Hearing Developmental Checklist, adapted from material published by ASHA and published by the Wisconsin Department of Health and Social Services (DHSS) in a brochure entitled "Baby Dear, Can You Hear?" This checklist is reproduced in Figure 1 (see section 2) and allows parents and caregivers to compare an infant's speech and hearing development to standards of normal development. The brochure also assists parents with helpful recommendations in the event that the child fails the criteria defined in the scoring system of this tool. The DPI and the DHSS encourage parents and caregivers to refer to this checklist often throughout the child's early years. Children who meet the brochure's criteria for failure require a referral to an audiologist for formal hearing screening and, if necessary, comprehensive evaluation. Copies of this brochure may be obtained by contacting the Wisconsin Department of Health and Social Services, Forms and Publication Office, 1 West Wilson Street, P.O. Box 7850, Madison, Wisconsin 53707; (608) 266-8001.

Tympanometry

Another important screening tool for children in this age group is the measurement of aural acoustic immitance, commonly known as tympanometry. Reliable tympanometric measurements can be made in children as young as seven months of age (corrected for prematurity). Tympanometric screening is a reliable method for identifying abnormalities of the middle ear, including the most common otologic disease in infants and children; otitis media with effusion (OME). This disease is accompanied by temporary and fluctuating hearing loss. This loss is thought to be the main factor in the speech, language, communication, and academic deficits so often found in children for whom the disease is recurrent or chronic in infancy and early childhood.

Since over half of all initial episodes of OME are asymptomatic, and 20 percent of all episodes are asymptomatic (Bluestone, et al, 1986), tympanometry is an important tool for identifying chil-

dren who suffer from chronic or recurrent OME. Tympanometry is especially useful in populations of children ages seven months to three years for whom pure-tone screening is not possible. OME is most prevalent during this period. The American Academy of Pediatrics (AAP) endorses the identification of infants and children with chronic and recurrent OME and encourages referring these children for assessment of hearing and communicative function. Figure 5 is the AAP Policy Statement, "Middle Ear and Language Development." The average hearing loss associated with middle ear effusion is 28 dB HL (Fria, et al, 1984), and is a significant barrier to the reception of the auditory cues to speech and language.

Estimates of the prevalence of sensorineural hearing loss in the infant population vary from .1 to .6 percent. (Downs, 1986; Matkin, 1984) The incidence of chronic and recurrent otitis media and concurrent hearing loss, however, is much higher. One-third of all children have three or more episodes in the first three years of life. (Bluestone et al., 1986) The prevalence of the disease peaks in early childhood, then declines with age and becomes progressively less common after age seven. (Bluestone et al., 1983) Craniofacial anomalies in children are often accompanied by a higher prevalence of otitis media and accompanying hearing loss. This is well-documented for children with a cleft palate or children with Down Syndrome. (Dahle and McCollister, 1986)

In order to forestall the developmental consequences of this common childhood malady, children with chronic and recurrent otitis media must be identified early in life when their speech, language, and communication skills develop rapidly. Routine medical evaluations for middle ear disease, supplemented by annual tympanometric screening in child care and early intervention programs could easily recognize most infants and toddlers with significant histories of persistent middle ear disease well before these children reach school age. Since the majority of hearing loss in school-age children is a result of active middle ear disease or its consequences, such preschool-age screening practices would identify the majority of school-age children with hearing loss before they enter school.

Most episodes of otitis media are self-limiting and resolve spontaneously without treatment in about four weeks. Therefore, children who fail the initial tympanometric screening must be rescreened in four to six weeks before the referral decision is made. This strategy will reduce the number of false positive referrals for medical evaluation and more reliably identify only those children with persistent middle ear problems.

Screenings that produce tympanograms which exhibit significantly reduced eardrum mobility meet the criteria for failure. These children should be rescreened using tympanometry in four to six weeks. In addition, rescreening in four to six weeks should also occur for children whose initial screening findings in either ear include a tympanogram showing normal mobility but with a middle ear negative pressure value of -250 deca Pascals (daPA) or more.

When the rescreening of children who were initially found to have significantly reduced mobility produces the same result for either ear, screeners should refer these children for medical and audiologic evaluation. Children who continue to yield normal tympanograms but with peaks at negative pressure values of -250 daPA or more when rescreened do not meet the criteria for failure. Screeners should monitor these children at eight-week intervals until the results meet the criteria for failing or passing the tympanometric screening. Medical and audiological referrals should never be based on a single tympanometry screening failure. Screening failures must occur in the same ear during separate screenings four to six weeks apart before a referral based on tympanometry screening can be justified.

Valid applications of the above criteria require adequate training and experience. Those who screen and make pass/fail and referral decisions should be thoroughly trained in interpreting tympanometric results (see section 3 for a discussion of the training elements for screeners of children in the first three years of life).

Visual Reinforcement Audiometry

Up until this point in the guide, none of the described screening tests for infants and toddlers from birth to age three are direct tests of auditory acuity. Developmentally normal children cannot learn the skills necessary for traditional behavioral pure-tone screening until at least age two and a half. Even then, a screener requires considerable skill to focus the child's attention for a long enough period of time and motivate the child sufficiently to complete the screening task.

The auditory sensitivity of infants and toddlers can be screened using frequency-specific stimuli by employing a technique called Visual Reinforcement Audiometry (VRA). Screeners can use this technique successfully to rule out all but mild

Figure 5

Middle Ear Disease and Language Development*

There is growing evidence demonstrating a correlation between middle ear disease with hearing impairment and delays in the development of speech, language and cognitive skills. A parent or other caretaker may be the first person to detect such early symptoms as irritability, decreased responsiveness, and disturbed sleep. Middle ear disease may be so subtle that a full evaluation for this condition should combine pneumatic otoscopy, and possibly tympanometry, with a direct view of the tympanic membrane. This statement is not meant to be a recommendation for specific treatment methods. When a child has frequently recurring acute otitis media and/or middle ear effusion persisting for longer than three months, hearing should be assessed and the development of communicative skills must be monitored.

The Committee feels it is important that the physician inform the parent that a child with middle ear disease may not hear normally. Although the child may withdraw socially and diminish experimentation with verbal communication, the parent should be encouraged to continue communicating by touching and seeking eye contact with the child when loudly and clearly speaking. Such measures, along with prompt restoration of hearing whenever possible, may help to diminish the likelihood that a child with middle ear disease will develop a communicative disorder. Middle ear disease can occur in the presence of sensory neural hearing loss. Any child whose parent expresses concern about whether the child hears should be considered for referral for behavioral audiometry without delay.

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Date of approval by Executive Board: July 1984
Date of publication: September 1984

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hearing loss in developmentally normal infants and toddlers as young as age six months corrected for prematurity. (Moore et al., 1977) VRA is an effective screening technique for children with normal development well into their second year of life. The technique has also been successful for developmentally delayed children for whom traditional audiometric screening methods are often unsuccessful. (Thompson, Wilson, and Moore, 1979)

The VRA procedure depends on the child learning the contingent relationship of a very rewarding and motivating visual display to the presence of carefully chosen, frequency-specific auditory stimuli. When the tester pairs the auditory stimulus with the visual reinforcer, the child is taught that the appearance of the visual reinforcer depends on the presence of the auditory signal. The visual reinforcer is located in close physical proximity to the source of the test sound during sound field testing *and* on the side of the room corresponding to the test ear in earphone testing. Once the child consistently turns to search for the visual reinforcer when an auditory signal appears, screening can begin. Most infants and toddlers from age six months to two years will respond reliably to soft sounds, enabling the screener to rule out all but mild hearing loss.

The screener should choose auditory stimuli that include low, mid, and high frequency sounds. Standard audiometric stimuli (ANSI 1989) that are appropriate for VRA screening involve narrow-band noise signals or warble-tone signals, with center frequencies at 4000 Hz and 1000 Hz, and single syllable speech sounds, such as "**buh**" that contain mostly low frequency energy. These stimuli are not produced by simple ANSI Type IV or Type V screening audiometers. (ANSI 1989) ANSI Type I or Type II audiometers are necessary to accomplish this testing. The 1000 Hz and 4000 Hz screening signals should be presented at 35 dB HL, and the low frequency speech sound should be presented at 25 dB HL. Children must respond consistently to all three screening stimuli to pass the screening test.

VRA screening of each ear can be carried out using earphones, but young children often do not tolerate earphones. VRA screening is more likely to be successful when done in the sound field using loudspeakers at some distance from the child (Primus, 1992). Sound field VRA screening can rule out all but mild hearing loss in the **better** ear only. For a full discussion of test protocols using VRA see the listings for Moore, Wilson, and Thompson, 1977; Primus, 1988; and Primus and Thompson, 1985 in Appendix E.

When a screening program identifies a hearing problem with any of these methods, the leadership personnel should refer the family to the local county Birth-to-Three program for evaluation and early intervention services in accordance with Part H of IDEA and Chapter HSS 90, Wisconsin Administrative Code. The services should include evaluation by a licensed audiologist and a physician experienced in evaluating and treating children with ear disease.

Recommended Procedures—Hearing Screening of Children Ages Three and Older

Beginning at about age three, developmentally normal children are able to successfully complete behavioral audiometric pure-tone hearing screening tests. Pure-tone audiometric screening is the most popular hearing screening method, because it directly assesses the child's auditory sensitivity for sounds that are important for understanding speech. While generally an easy test to administer to most school-age children, it can be very difficult to administer to children who are young, physically disabled, developmentally delayed, or unresponsive. Techniques and strategies for screening difficult to test children appear in section 5. The following information describes the procedures and the pass/fail and referral criteria for pure-tone audiometric screening.

Screening tests other than pure-tone are appropriate for some children in this population. For example, annual tympanometric screening is appropriate for children in the following categories: ages three to five years; those older than five who cannot be screened using pure-tone methods; and those who receive services for exceptional educational needs such as cognitive disability, hearing loss, severe developmental delay, and severe physical disability. Tympanometry should not be used as a screening tool for school-age children in regular education. However, it can be used for the children who have failed both parts of the pure-tone audiometric screening process. When used in this context, the tympanograms simply add additional information for the physician who will evaluate the child; they should not contribute to the decision to refer for evaluation. In addition, whenever three- to five-year-olds cannot be screened successfully using pure-tone methods, the screener should apply the Speech and Hearing Developmental

Checklist shown in this guide as Figure 1, found in section 2.

Otoscopic screening is also an option for all infants, toddlers, and children. Given the difficulties of this procedure with young children, however, screeners use it more often with populations of school-age children. Screeners should seek input from a physician experienced in otoscopic evaluations of children before making the decision to include otoscopy.

Pure-Tone Screening

As described in section 3 of this guide, pure-tone screening requires the following: appropriately trained and supervised personnel, adequate acoustic environments, and equipment that meets specific performance and calibration requirements. Even though programs calibrate test equipment annually, testers should perform daily listening checks to verify the integrity of the equipment. Instructions for performing the daily listening check are included in the "Instructions for Performing the Initial Audiometric Pure-Tone Hearing Screening Test" (Figure 6). The program director may wish to incorporate this instruction summary into the screening training program.

As in the protocol for tympanometric screening, pure-tone screening should be a two-step process, with screening sessions occurring four weeks apart. This test-retest interval reduces the number of false positive referrals because it allows time for spontaneous resolution of middle ear disease, the most frequent cause of hearing screening failure in school-age children. In addition, children who fail the initial screening test should be rescreened during the same test session. Careful reinstruction as well as repositioning of the earphones can significantly reduce failure rates. Only manual and individual pure-tone screening is recommended. Group screening and automated pure-tone screening methods are not recommended, because they are not effective with young children.

Instructing the Child

Screeners should expect that *many* developmentally normal four-year-olds and *all* developmentally normal five-year-olds will be able to successfully complete a traditional pure-tone hearing screening task. The task, explained in Figure 6, requires a motor activity from the child in response to the test tone. Successful screening is dependent on the child understanding exactly what is expected. The instructions in Figure 6 should be delivered simply and clearly, and repeated as necessary to complete the screening process. For some reluctant four- and five-year-olds, the screener may have to provide demonstrations. That process is also explained in Figure 6. Additional procedural information is provided in Figure 6, and in Figure 7, "Instructions for Performing the Audiometric Pure Tone Hearing Rescreening Test."

Most developmentally normal three-year-olds and *many* developmentally normal four-year-olds will not be screenable using the techniques referred to in Figures 6 and 7. For these children, the task must be more interesting and rewarding in order to elicit motor actions in response to test tones. For these children, "play audiometry" techniques are necessary, because they substitute a stimulating and motivating action for the simple motor responses that older children use. For example, screeners may train younger children to throw a colorful pop-bead into a noisy container each time a test signal is present. Testers can make this motivating activity even more meaningful if they offer strong positive feedback when the child successfully accomplishes the task.

Screeners should learn this technique in a structured, supervised training experience that results in satisfactory independent performance. The program's consulting audiologist or other expert screener should provide the training and supervision. Because screening using play audiometry may require several sessions, it is very helpful if parents or other caregivers can contribute to the child's training. Appendix C contains instructions to parents for training their children in this task. This "Sample Home Conditioning Program" can also serve as a guide for training screening personnel.

Prior to conducting the hearing screening test, the tester must ensure that the audiometer is working properly and that the test room is quiet enough to permit valid testing.

Test Signals

For the initial hearing screening, pure-tone stimuli with frequencies of 1000, 2000, and 4000 Hz should be used. "Guidelines for Identification Audiometry" (ASHA, 1985) recommend including 500 Hz in the screening process if tympanometry is not part of the screening process *and* if ambient noise levels in the screening environment permit. Experience in public school screening programs has shown that ambient noise levels are almost always too high for screening at 500 Hz, and if

Instructions for Performing the Initial Audiometric Pure-Tone Hearing Screening Test

Audiometer Performance Check

With the audiometer set to a loudness of 60 dB and a frequency of 2000 Hz and set to "normally on," determine that the tones reaching both earphones are steady (no static or interruptions). This should be done while the tester wiggles the earphone wires of both earphones at each end. If static or tone interruptions are heard, the audiometer must be repaired before it can be used.

Test Room Noise Level Check

The test room must be quiet enough so that the tester or a young adult with normal hearing can clearly hear all of the test tones at the screening intensity levels specified in "PASS/FAIL CRITERIA" below. If all of the test tones cannot be heard clearly, a quieter test room must be found for screening.

Pass / Fail Criteria

1. The frequencies of 1,000 Hz, 2,000 Hz, and 4,000 Hz should be used.
2. The intensity dial (H.T.L. Dial) should be set at 20 dB.
3. The child must respond correctly two out of three times at each frequency in both ears in order to pass the test.
4. If there is no response at 4,000 Hz at 20 dB, the intensity may be raised to 25 dB. If the child still does not respond, he/she has failed the test.

Instructions to the Child

The instructions to the child should be simple and clear so that he/she knows exactly what is expected of him/her.

1. Explain that the tones will be soft and may be hard to hear.
2. Seat the child facing 45° away from the tester so that the tester can observe the child's reactions and so that the child cannot see the tester operating the audiometer.
3. Have the child place his or her hand on his or her knee while waiting for the tone.
4. Instruct the child to raise his or her hand every time he/she hears the tone even if it is very soft and difficult to hear.
5. Instruct the child to raise his or her hand right away as soon as he/she hears the tone.
6. Instruct the child to return his or her hand to his or her knee when the tone stops.
7. Be sure the child knows to which ear the tones will be presented.

When the Child is Ready for Screening

1. Expand the headband and place the red earphone on the right ear and the blue earphone on the left ear.
2. The tester should make certain that the opening in the center of the earphone is in direct line with the ear canal. Place the earphones on the child while facing him.
3. Adjust the earphones to the approximate size of the child's head before placing them in position. The headband should rest squarely in the center of the child's head.
4. Start with a one second tone presentation in the right ear at 1,000 Hz. If the child raises his or her arm, allow the child to return his or her hand to his or her knee. Present the tone a second time, and if he or she does not respond, present the tone a third time. The

child must respond correctly two out of three times in order to pass the screening in the right ear at 1,000 Hz.

5. Repeat the procedure in number four for 2,000 Hz and 4,000 Hz in the right ear. Then repeat the entire three-tone sequence for the left ear. The child must pass the screening at all tones in both ears in order to pass the screening test. Remember: The intensity may be raised to 25 dB at 4,000 Hz if the child does not hear the 4,000 Hz tone at 20 dB in either ear.
6. If the child fails the screening, he or she should be rescreened by another tester immediately, if possible, or by the same tester after a short rest period. Carefully reinstruct the child before rescreening.

Cautions

1. Do not develop a rhythmic presentation. Vary the timing of the tone presentations so that the child cannot anticipate when the next tone is coming.
2. The child should be seated facing 45° away from the tester. The child is positioned correctly when he or she cannot see the tester's hand operating the audiometer and the tester can see the side of the child's face.
3. Keep the length of the tones roughly equal. A one-second tone duration is desirable.
4. It is not necessary to tell the child the results of the screening test. Never tell a child he or she has failed the test. If a child asks about the results, simply say, "You did a good job on your hearing test today."
5. You may not be able to test some children. Some children will give false or no responses even after you have taken the time to carefully reinstruct and demonstrate the task for them (see "Demonstration Techniques" below). Be sure to report which children were untestable to the person in charge of your hearing screening program.

Demonstration Techniques

1. Place the earphones on the table near the child, with the centers of the earphones facing the child.
2. Position the child to face you.
3. Adjust the intensity/H.T.L. dial to 110 dB and the frequency dial to 2,000 Hz.
4. Present the tone and demonstrate the desired response by raising your hand.
5. Repeat number four and encourage the child to join you in responding. You may demonstrate softer tones by presenting tones at 70 to 80 dB.
6. Once the child is responding correctly all by him or herself, resume the normal screening process as explained above.

All children who fail the audiometric pure-tone hearing screening test should be referred for rescreening a minimum of four weeks later.

Figure 7

Instructions for Performing the Audiometric Pure-Tone Hearing Rescreening Test

Selecting the Test Environment

A quiet test environment is absolutely essential. A room is quiet enough if the test tones can be heard easily by a person with normal hearing. If the tester's hearing is not normal, locate a young adult with no history of hearing problems to listen to the test tones. Do not proceed with the rescreening if all the test tones cannot be heard easily. The room noise sources must be located and reduced or a quieter room must be found if the test tones cannot be heard easily.

Audiometer Performance Check

With the audiometer set to a loudness of 60 HL and a frequency of 2,000 Hz and set to "normally on," determine that the tones reaching both earphones are steady (no static or interruptions). This should be done while you wiggle the earphone wires of each earphone at both ends. If any interruption of the tone is heard, do not proceed with the rescreening until the audiometer is repaired. Next, without changing the settings of the audiometer, move the ear selector switch back and forth between "left and right." The tone should be equally loud in both ears if the listener's hearing is normal and if the audiometer is working properly.

Instructions to the Child

The tester's instructions to the child should be simple and clear so that he or she knows exactly what is expected of him or her.

1. Explain that the tones will be soft and may be difficult to hear.
2. Seat the child facing 45° away from the tester so that the tester can observe the child's reactions and so that the child cannot see the tester operating the audiometer.
3. Have the child place his or her hand on his or her knee while waiting for the tone.
4. Instruct the child to raise his or her hand every time he or she hears the tone, even if it is very soft and difficult to hear.
5. Instruct the child to raise his or her hand right away as soon as he or she hears the tone.
6. Instruct the child to return his or her hand to his or her knee when the tone stops.
7. Be sure the child knows to which ear the tone will be presented.

When the Child Is Ready for Screening

1. Expand the headband and place the red earphone on the right ear, the blue earphone on the left ear.
2. The tester should make certain that the opening in center of the earphone is in direct line with the ear canal. Place the earphones on the child while facing him.
3. Adjust the earphones to the approximate size of the child's head before placing them in position. The headband should rest squarely in the center of the head.
4. Let the child know how he or she is doing. Praise him or her if he or she is doing well and reinstruct him or her if he or she is having difficulty with the task.

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Demonstration Techniques

It may be necessary to demonstrate the test for some children who do not respond to the tones. Demonstration techniques are explained in the "Instructions for Performing the Initial Audiometric Pure-Tone Hearing Screening Test." (Figure 6)

Pass / Fail and Referral Criteria

1. The frequencies of 1,000 Hz, 2,000 Hz, and 4,000 Hz should be used.
2. The audiometer loudness will be set to 20 dB HL for 1,000 and 2,000 Hz and 25 dB HL for 4,000 Hz.
3. The child must respond two out of three times to pass each frequency in each ear.
4. If the child passes at 1,000 and 2,000 Hz but fails at 4,000 Hz in either ear, then test 3,000 Hz at 20 dB HL in that ear.
5. Failure at 1,000 or 2,000 Hz in either ear is a rescreening failure. Failure at 4,000 Hz only in either or both ears is not a failure but will require a retest next year.
6. Failure at 3,000 AND 4,000 Hz in either or both ears is a rescreening failure.

Verifying the Failure

There are causes other than hearing loss for failure on the rescreening test. It is the tester's job to rule out these causes before accepting the failure. If a child fails any frequency in either ear,

1. Reposition the earphones and rescreen. The center of the earphone must be directly over the opening of the ear canal.
2. Increase the loudness of the tone failed to 60 dB HL to be sure the child understands the task and is paying attention. When it is clear that the child is paying attention and understands the task, reduce the loudness to the screening level and retest. If the child does not understand or is not paying attention, proceed to number three below.
3. Reinstruct the child, and remind him or her that the tones are soft. If necessary, remove the earphones and repeat the demonstration activity. Be generous with your praise for correct responding.
4. If a child cannot learn the screening task and does not respond to any 60 dB sounds, report him or her to the person in charge at your hearing screening program.

Referrals

Parents of children who fail the rescreening test should be informed of the failure and should be encouraged to obtain medical and audiological evaluations for their children. It is important that hearing screening personnel seek the results of the medical and audiological evaluations. If the hearing loss does not resolve with medical treatment, the child's school should be made aware of the problem. Periodic rescreening of children referred for medical evaluations and treatment is important to document the resolution of temporary hearing losses and the persistence of other hearing losses.

screeners include that frequency in the screening protocol, it increases the false positive referral rates substantially. Finally, because few significant hearing problems in children affect auditory sensitivity at 500 Hz and not any of the other three test frequencies, screeners may eliminate the 500 Hz stimuli from the screening protocol. Screening should occur at levels of 20 dB HL for the 1000 and 2000 Hz signals and at 25 dB HL for the 4000 Hz signal. (ANSI, 1989) An additional test signal should be added to the rescreening session. During the rescreening session, screening at 3000 Hz at 20 dB HL (ANSI, 1989) should also occur in the ear(s) in which the child passes the screening at all frequencies except 4000 Hz.

Pass / Fail and Referral Criteria

The child must respond reliably to 75 percent of the presentations of all test signals in both ears to pass the initial pure-tone screening test(s). During the initial screening session, a child who fails should receive a second opportunity to pass the screening after careful reinstruction and repositioning of the earphones. When a child fails the initial pure-tone screening, the program should schedule a rescreening session for four weeks later. If signs of acute ear disease are present, or if the screener notes significant ear drum or ear canal abnormalities, the program director should make a prompt medical referral.

During the rescreening session, failure at 1000 or 2000 Hz in either ear should be followed by a medical and audiological evaluation. In the event of failure at only 4000 Hz in either or both ears, the tester must rescreen at 3000 Hz at 20 dB HL. Failure at both 3000 and 4000 Hz in either ear should result in medical and audiological evaluation. Failure at only 4000 Hz in either ear may not justify a medical referral. Periodic audiometric rescreening twice annually, however, should occur to rule out further decreases in auditory sensitivity at other test frequencies. In addition, the child's family should be notified, and the child's risks of dangerous noise exposure should be assessed. If such exposures exist, precautions should be taken to avoid them. Parents may wish to seek an audiological evaluation to establish a formal audiometric baseline of hearing sensitivity.

Alternative Pure-Tone Screening Model

The ASHA model for pure-tone hearing screening, as described in the "Guidelines for Identification Audiometry" (ASHA, 1985), differs in some respects from the pure-tone protocol recommended above. A primary difference is that the ASHA model recommends that programs refer all children who fail the screening process for evaluation by an audiologist prior to the medical referral. The rationale for this step is: "Some persons, particularly young children, will fail both the screening and rescreening procedures and then yield normal thresholds on an audiologic evaluation." This statement implies that something in the screening process (possibly the environment or errors by screeners) generates false positive results, and that skilled threshold testing by an audiologist is necessary to keep false positive test results to an acceptable level.

Hearing screening coordinators should be aware of the following implications of choosing this model:

- Threshold testing requires very quiet test environments usually found only in sound-treated test rooms.
- Equipment must be capable of masked threshold testing and meet strict ANSI standards.
- Hearing loss is a medical symptom which requires a prompt referral for medical evaluation when the screening program detects a possible problem. Referral for threshold testing or evaluation by an audiologist or other skilled tester should not result in delays that prevent prompt medical evaluation.
- Unless the services of an audiologist are part of or supported by the screening program, audiologic testing before the medical evaluation may result in added costs to the family. Many third-party payers will not reimburse for audiologic testing unless it is part of a medical evaluation.
- Audiometric evaluations and threshold test results obtained during the screening process may not represent the status of the child's hearing at the time of the medical evaluation. Since medical evaluations are often significantly delayed after the family is notified of the failure, repeat testing will likely be required.
- Threshold tests alone should not be referred to as "hearing evaluations," even when done by a licensed audiologist. Threshold testing is only one part of a hearing evaluation. Persons who include threshold test results with medical referrals should ensure that physicians understand that the results do not constitute a hearing evaluation. Chapter 459 of the Wisconsin statutes restricts those who may do hearing evaluations to licensed audiologists. However, licensed hearing instrument specialists may measure hearing for the purposes of selecting, adapting, or selling hearing aids.

If the primary rationale for conducting audiological testing prior to medical referral is the reduction of false positive referrals, the director may wish to consider other means to accomplish the same result. Well-trained and supervised screeners are the most important element in reducing false positive screening results. This document provides guidance in minimal training elements for the screeners listed in section 3.

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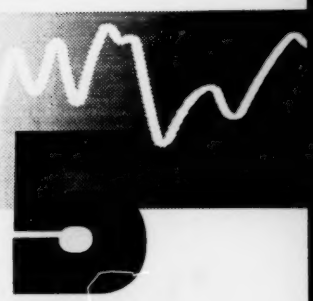

Barriers to Successful Childhood Hearing Screening

When adequately trained and supervised personnel screen for hearing loss using traditional procedures in appropriate environments, most children will be screened successfully. However, those who perform the initial screening test are frequently unable to screen some school children successfully. It is important to understand that this is a normal occurrence, and they should feel no pressure to produce only "pass" or "fail" results for all children. It is vital that initial screeners be encouraged to report all screening tests that are of low reliability or are unsuccessful. When these results occur, a more experienced individual should attempt a screening. That person may be the audiologist who consults with the screening program, the hearing screening director, or other qualified person designated by the director and consulting audiologist to assume this role. Repeated screening attempts spanning several days or weeks may be necessary, and sometimes referral to a licensed audiologist in a clinical setting may be required.

In addition to school-age children who cannot be screened successfully, large numbers of children in high-risk and difficult-to-test populations are not included in hearing screening efforts. (Frye-Osier and Wahlton, 1988) This section examines the barriers that prevent the successful hearing screening of some children and the exclusion of others from screening programs and explores possible resolutions.

Misunderstanding the Need to Screen All Targeted Children

Many people outside the field of communicative disorders assume that young children with socially adequate speech and language and normal auditory responsiveness in favorable communication situations have normal hearing. The reality is that young children can exhibit these "normal" behaviors while experiencing developmentally significant mild and high frequency, unilateral, or fluctuating hearing loss. Unless this fact is understood, such children who cannot be screened successfully may be dismissed from further efforts to screen for hearing loss.

One way to rule out significant hearing loss in children is to employ the formal hearing screening procedures described in this publication. Subjective screening methods, informal "testing" with noisemakers, and subjective impressions of auditory acuity do not work and will miss children with significant hearing impairments. In order to facilitate valid screening for young or uncooperative children, screeners must provide careful parental counseling so families will understand the importance of formal hearing screening and the use of valid screening tools and procedures. This empowerment of parents is essential if they are to advocate for appropriate screening services from their medical providers.

Belief That Rehabilitation Is Impossible for Some

Children with severe physical, cognitive, emotional, or multiple disabilities are often very difficult to screen for hearing loss, even by skilled audiologists. Many of these children in Wisconsin have not been screened for hearing loss before they enter school, and the majority of them are not screened in their school hearing screening programs. (Frye-Osier and Wahlton, 1988)

Certain beliefs and attitudes prevent vigorous efforts to screen for hearing loss in this population. Some people believe that hearing assessment and effective auditory rehabilitation is impossible in this population. Actually, audiologists can successfully assess the hearing of many of these children and provide important auditory rehabilitative interventions.

Other people believe that the developmental potential and the quality of life are so limited for these children that little will be gained for the effort necessary to deal with their loss of hearing. Hearing loss is far more likely for the child with a severe disability than for other children, and the consequences are more serious. These children often face huge obstacles to learning and communication in addition to possible sensory impairments. In reality, hearing loss may be among the easiest of the child's problems to identify and rehabilitate. To allow hearing loss to go undetected in these children is to impose unnecessary additional barriers to communication and learning and to reduce their quality of life by depriving them of the auditory experiences that people with normal hearing enjoy.

Difficulty in Locating Resources

Successful hearing screening of children who are young, unresponsive, or severely disabled can be expensive and time-consuming. Screening programs often cannot accomplish screening these children in traditional screening environments and must refer them to a licensed audiologist experienced in assessing difficult-to-test children. Not all communities in Wisconsin have the necessary audiologic expertise, and this lack of personnel may require the child's family to travel. In addition, the screening process may take multiple visits to complete, may entail parental participation in training the child, and may necessitate the involvement of a physician and the use of sedatives or anesthetics.

The following resources are available to families to assist in securing needed services:

- County and/or city public health programs serve every Wisconsin community. Health professionals in these agencies are knowledgeable about the resources, both public and private, that are available to assist families in securing needed services.
- The Wisconsin Health Check Program is responsible for providing screening services for eligible children. This program also includes transportation services for eligible children.
- County birth to three programs screen and evaluate children who are identified as being potentially eligible for services. These programs include service coordination, family education, audiology services, and transportation.
- The Wisconsin Program for Children with Special Health Care Needs (PCSHCN), located in the Wisconsin Department of Health and Social Services, can be contacted by calling 800-441-4576 (voice), or 608-266-5485 (TDD). The PCSHCN provides financial assistance for medical evaluation and treatment services for children whose families meet the eligibility requirements of the program. In addition, program staff offer consultative services to families and can assist in locating medical and audiologic services in their communities.
- Head Start programs can assist eligible children from low-income families with obtaining hearing screenings. Transportation services may also be provided.
- Public schools must provide ongoing special education screening programs for all children in the school district who have not graduated from high school. The local education agency (LEA) must evaluate all children that it suspects have handicapping conditions and who may be eligible for special education services. While LEAs are not specifically required to screen for hearing impairment in children in all EEN categories, they must evaluate children in all areas related to the suspected handicapping conditions. If the LEA suspects a hearing impairment in a child who is being evaluated for special education services, the LEA must ensure that a hearing evaluation takes place.

Successful hearing screening of all infants and children can be a reality, especially when there are coordinated community screening efforts beginning at birth and continuing into the early school years. Hearing screening leadership people in every community must break down the barriers of misinformation and inaccurate beliefs and advocate for the resources necessary to accomplish the task.

Summary

Quality hearing screening programs for infants and children, delivered as early in life as possible, are essential to limiting or eliminating the negative developmental and social consequences of hearing loss. Therefore, this guide is offered to provide the reader with the information necessary for justifying and designing valid and reliable hearing screening programs for appropriate populations of children. The guide emphasizes the need for the involvement of a licensed audiologist in every hearing screening program, the importance of highly trained and well-supervised screening personnel, the importance of comprehensive hearing screening services in the preschool years, and the involvement of many service delivery systems in the community. In addition, the guide attempts to provide a comprehensive treatment of the critical components of quality hearing screening programs, screening test protocols, and equipment issues and options.

Improvement of infant and childhood hearing screening programs in Wisconsin will require a new commitment of effort and resources and enhanced collaboration among individuals, agencies, and families in every community. Only when there is a community consensus about the importance of quality hearing screening programs for all children will progress occur. This consensus will require communication, collaboration, and the resolution of difficult issues related to prioritizing the needs of children in the context of limited resources. Until a consensus is reached, Wisconsin will not be able to accomplish the important task of identifying every child with impaired hearing as early in life as possible. Hopefully, this guide will stimulate and promote the necessary consensus building.

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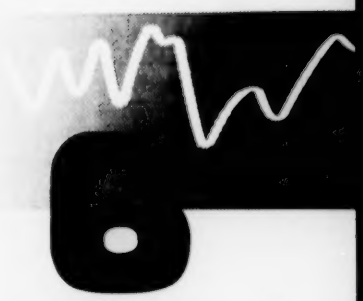

Appendixes

A. *Joint Committee on Infant Hearing 1990 Position Statement*

B. *Resources and Educational Materials for Parents and Caregivers*

C. *Sample Home Conditioning Program*

D. *Glossary*

E. *Relevant Materials*

Appendix A

Joint Committee on Infant Hearing 1990 Position Statement*

The following expanded position statement was developed by the Joint Committee on Infant Hearing. Representatives of the member organizations who prepared this statement include the following: American Speech-Language-Hearing Association—Fred H. Bess, chair, Noel D. Matkin and Evelyn Cherow, ex officio; American Academy of Otolaryngology-Head and Neck Surgery—Kenneth M. Grundfast, co-chair; American Academy of Pediatrics—Allen Erenberg and William P. Potsic; Council for Education of the DEAF—Lita Aldridge and Barbara Bodner-Johnson; Directors of Speech and Hearing Programs in State Health and Welfare Agencies—Thomas Mahoney. Consultants: Alan Salamy and Gregory J. Matz. ASHA monitoring vice president: Ann L. Carey.

I. Background

The early detection of hearing impairment in children is essential in order to initiate the medical and educational intervention critical for developing optimal communication and social skills. In 1982, the Joint Committee on Infant Hearing recommended identifying infants at risk for hearing impairment by means of seven criteria and suggested follow-up audiological evaluation of these infants until accurate assessments of hearing could be made (ASHA, 1982). In recent years, advances in science and technology have increased the chances for survival of markedly premature and low birth weight neonates and other severely compromised newborns. Because moderate to severe sensorineural hearing loss can be confirmed in 2.5 percent to 5.0 percent of neonates manifesting any of the previously published risk criteria, auditory screening of at-risk newborns is warranted (Hosford-Dunn, et al., 1987; Jacobson and Morehouse, 1984; Mahoney and Eichwald, 1987; Stein, et al., 1983). Those infants who have one or more of the risk factors are considered to be at increased risk for sensorineural hearing loss.

Recent research and new legislation (PL 99-457) suggest the need for expansion and clarification of the 1982 criteria. This 1991 statement expands the risk criteria and makes recommendations for the identification and management of hearing-impaired neonates and infants. The Joint Committee recognizes that the performance characteristics of these new risk factors are not presently known; further study and critical evaluation of the risk criteria are therefore encouraged. The protocols recommended by the Committee are considered optimal and are based on both clinical experience and current research findings. The Committee recognizes, however, that the recommended protocols may not be appropriate for all institutions and that modifications in screening approaches will be necessary to accommodate the specific needs of a given facility. Such factors as cost and availability of equipment, personnel and follow-up services are important considerations in the development of a screening program (Turner, 1990).

II. Identification

A. Risk Criteria: Neonates (birth–28 days)

The risk factors that identify those neonates who are at-risk for sensorineural hearing impairment include the following:

1. Family history of congenital or delayed onset childhood sensorineural impairment.

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2. Congenital infection known or suspected to be associated with sensorineural hearing impairment such as toxoplasmosis, syphilis, rubella, cytomegalovirus and herpes.
3. Craniofacial anomalies including morphologic abnormalities of the pinna and ear canal, absent philtrum, low hairline, et-cetera.
4. Birth weight less than 1500 grams (-3.3 lbs.).
5. Hyperbilirubinemia at a level exceeding indication for exchange transfusion.
6. Ototoxic medications including but not limited to the aminoglycosides used for more than five days (e.g., gentamicin, tobramycin, kanamycin, streptomycin) and loop diuretics used in combination with aminoglycosides.
7. Bacterial meningitis.
8. Severe depression at birth, which may include infants with Apgar scores of 0-3 at 5 minutes or those who fail to initiate spontaneous respiration by 10 minutes or those with hypotonia persisting to two hours of age.
9. Prolonged mechanical ventilation for a duration equal to or greater than 10 days (persistent pulmonary hypertension).
10. Stigmata or other findings associated with a syndrome known to include sensorineural hearing loss (Waardenburg or Usher's Syndrome).

B. Risk Criteria Infants (29 days–two years)

The factors that identify those infants who are at-risk for sensorineural hearing impairment include the following:

1. Parent/caregiver concern regarding hearing, speech, language and/or developmental delay.
2. Bacterial meningitis.
3. Neonatal risk factors that may be associated with progressive sensorineural hearing loss (cytomegalovirus, prolonged mechanical ventilation and inherited disorders).
4. Head trauma especially with either longitudinal or transverse fracture of the temporal bone.
5. Stigmata or other findings associated with syndromes known to include sensorineural hearing loss (Waardenburg or Usher's Syndrome).
6. Ototoxic medications including but not limited to the aminoglycosides used for more than five days (gentamicin, tobramycin, kanamycin, streptomycin) and loop diuretics used in combination with aminoglycosides).
7. Children with neurodegenerative disorders such as neurofibromatosis, myoclonic epilepsy, Werdnig-Hoffman disease, Tay-Sach's disease, infantile Gaucher's disease, Nieman-Pick disease, any metachromatic leukodystrophy, or any infantile demyelinating neuropathy.
8. Childhood infectious diseases known to be associated with sensorineural hearing loss (e.g., mumps, measles).

III. Audiologic Screening Recommendations for Neonates and Infants

A. Neonates

Neonates who manifest one or more items on the risk criteria should be screened, preferably under the supervision of an audiologist. Optimally, screening should be completed prior to discharge from the newborn nursery but no later than three months of age. The initial screening should include measurement of the auditory brainstem response (ABR) (ASHA, 1989). Behavioral testing of newborn infants' hearing has high false-positive and false-negative rates and is not universally recommended. Because some false-positive results can occur with ABR screening, ongoing assessment and observation of the infant' s auditory behavior is recommended during the early stages of intervention. If the infant is discharged prior to screening, or if ABR screening under audiologic supervision is not available, the child ideally should be referred for ABR testing by three months of age but never later than six months of age.

The acoustic stimulus for ABR screening should contain energy in the frequency region important for speech recognition. Clicks are the most commonly used signal for eliciting the ABR and contain energy in the speech frequency region (ASHA, 1989). Pass criterion for ABR screening is a response from each ear at intensity levels 40 dB nHL or less. Transducers designed to reduce the probability of ear-canal collapse are recommended.

If consistent electrophysiological responses are detected at appropriate sound levels, then the screening process will be considered complete except in those cases where there is a probability of progressive hearing loss (family history of delayed onset, degenerative disease, meningitis, intrauterine infections or infants who had chronic lung disease, pulmonary hypertension or who received medications in doses likely to be ototoxic). If the results of an initial screening of an infant manifesting any risk criteria are equivocal, then the infant should be referred for general medical, otological, and audiological follow-up.

B. Infants

Infants who exhibit one or more items on the risk criteria should be screened as soon as possible but no later than three months after the child has been identified as at-risk. For infants less than six months of age, ABR screening (see II A.) is recommended. For infants older than six months, behavioral testing using a conditioned response or ABR testing are appropriate approaches. Infants who fail the screen should be referred for a comprehensive audiologic evaluation. This evaluation may include ABR, behavioral testing (6 months) and acoustic immittance measures (see ASHA, 1989 Guidelines, for recommended protocols by developmental age).

IV. Early Intervention for Hearing-Impaired Infants and Their Families

When hearing loss is identified, early intervention services should be provided, in accordance with Public Law 99-457. Early intervention services under PL 99-457 may commence before the completion of the evaluation and assessment if the following conditions are met: (a) parental consent is obtained, (b) an interim individualized family service plan (IFSP) is developed, and (c) the full initial evaluation process is completed within 45 days of referral.

The interim IFSP should include the following:

A. The name of the case manager who will be responsible for both implementation of the interim IFSP and coordination with other agencies and persons;

B. The early intervention services that have been determined to be needed immediately by the child and the child's family.

These immediate early intervention services should, include the following:

1. Evaluation by a physician with expertise in the management of early childhood otologic disorders.
2. Evaluation by an audiologist with expertise in the assessment of young children, to determine the type, degree, and configuration of the hearing loss, and to recommend assistive communication devices appropriate to the child's needs (hearing aids, personal FM systems, vibrotactile aids).
3. Evaluation by a speech-language pathologist, teacher of the hearing-impaired, audiologist, or other professional with expertise in the assessment of communication skills in hearing-impaired children, to develop a program of early intervention consistent with the needs of the child and preferences of the family. Such intervention would be cognizant of and sensitive to cultural values inherent in familial deafness.
4. Family education, counseling and guidance, including home visits and parent support groups to provide families with information, child management skills and emotional support consistent with the needs of the child and family and their culture.
5. Special instruction that includes:
   a. the design and implementation of learning environments and activities that promote the child's development and communication skills;
   b. curriculum planning that integrates and coordinates multidisciplinary personnel and resources so that intended outcomes of the IFSP are achieved; and,
   c. ongoing monitoring of the child's hearing status and amplification needs and development of auditory skills.

V. *Future Considerations for Risk Criteria*

Because of the dynamic changes occurring in neonatal-prenatal medicine, the committee recognizes that forthcoming research may result in the need for revision of the 1991 risk register. For example, the committee has concerns about the possible ototoxic effects on the fetus from maternal drug abuse; however, present data are insufficient to determine whether the fetus or neonate are at risk for hearing loss. In addition, yet-to-be-developed medications may have ototoxic effects on neonates and infants. Therefore, the committee advises clinicians to keep apprised of published reports demonstrating correlations between maternal drug abuse and ototoxicity and between future antimicrobial agents and ototoxicity. Clinicians should also take into account the possible interactive effects of multiple medications administered simultaneously. Finally, the committee recommends that the position statement be examined every three years for possible revision.

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Appendix B

Resources and Educational Materials for Parents and Caregivers

The American Speech-Language-Hearing Association *
10801 Rockville Pike
Rockville, MD 20852
(800) 638-6868 (Voice/TDD)

The Channing L. Bete Co., Inc.
200 State Road
South Deerfield, MA 01373
(413) 665-7611

The Alexander Graham Bell Association for the Deaf *
3417 Volta Place, N.W.
Washington, DC 20007-2778
(202) 337-5220 (Voice/TDD)

The National Information Center on Deafness
Gallaudet University
800 Florida Ave. N.E.
Washington, DC 20002-3695
(202) 651-5051 (Voice)
(202) 651-5052 (TDD)

Minnesota Foundation for Better Hearing and Speech **
166 4th Street East, Suite 320
St. Paul, MN 55101
(612) 223-5130 (Voice/TDD)

National Association for Hearing and Speech Action
814 Thayer Avenue
Silver Spring, MD 20901
(800) 638-8255 (Voice/TDD)

* some materials available in Spanish
** some materials available in Hmong

Sample Home Conditioning Program

Dear Parents:

In order for us to evaluate your child's hearing, it is necessary that he or she be able to perform a task when he or she hears a sound. If your child could perform such a task when he or she arrives for the hearing test, it would be very helpful.

The following is a program we have written for you and your child to teach him or her to perform the required tasks for our tests. Begin the program slowly and do only a small amount each day. Do not force him or her to do the task, but make it part of a game and a pleasant experience. We would appreciate it if you would bring the toys (blocks, rings, etc.) you use in the program with you when you come for the test. Your child will then be working with familiar toys during the test. If you have headphones at home, have your child listen to music or other programs with them. Explain to your child that he or she will be playing a listening game with the headphones on at the testing center.

Purpose. We would like to get your child to respond to sound by performing a certain task.

Guidelines.

- The training should be pleasant and fun for your child.
- The training should be done for short periods of time, five to ten minutes.
- When your child is doing good work, be sure and let him or her know by using praise or other rewards.

Materials. The following are suggested materials or toys that can be used to follow the program. They are only suggestions, and you may use other items that you think may work better with your child.

Noisemakers:	xylophone drums rattle bells
Toys:	plastic rings and pole on which to place the rings blocks and can to put blocks into pegs and a pegboard macaroni into a shoebox buttons into a coffee can

Goals. The goal is that each time you hit the xylophone, hit the drums, shake a rattle, or ring the bells, your child will respond to the sound by: (1) putting a plastic ring on the pole or (2) putting a block into a can, or (3) putting a piece of macaroni into a shoebox, or (4) any other similar activity. It is important that your child respond to the sound and not to the movement of your hand while you hit the xylophone. This is not only important with the xylophone but with any noisemaker used.

Procedure. All the examples we present will use the xylophone and putting blocks into a can. You may substitute any noisemakers or toys that your child enjoys. For instance, if she would rather put small cars in a truck when she hears the sound, let her do it.

Step One. Sit down facing your child and explain in simple words that when you hit the xylophone, you want him to put a block into the can. You should demonstrate this several times. Before you hit the xylophone, hold the block close to your ear. That way your child will get the idea of listening carefully.

Step Two. Give your child the block and have her hold it close to her ear. You may hold her hand and help her put the block into the can when you make the sound. Be sure to praise your child (or give her another type of reward she likes) each time he or she does well. Continue this step until she starts doing it without your assistance.

Step Three. When your child starts putting the block into the can with no assistance four out of five times, continue facing him; but do not let him see you hit the xylophone (for example, put it under the table). You can tell him it is a new game and that now he has to put the block into the can by only listening for the sound. You may have to help your child put the block into the can the first couple of times. Reward him (praise or other) each time he does well. You should continue this until he can do it seven out of ten times.

Step Four. Sit down behind your child. You again hit the xylophone and help her put the block into the can the first couple of times. You may explain this step to her by saying, "This is the hardest job, and if you hear this you are a good listener." This is to make sure that she is responding to the sound and not to you when you make the sound. Again, reward her each time he or she does well.

Step Five. If your child is doing well, you might try a different noisemaker and a different toy. He will then get used to different sounds and learn to respond in different ways. This may provide some variety in the testing and hold his attention for a longer period of time. Be sure to reward him or her for doing the new task.

Step Six. If your child is not doing well, you should also try a different noisemaker and/or a different toy and/or a different reward. All children do not enjoy the same things. Your child may not respond to the xylophone by putting blocks into a can, but she might respond to a bell by stacking blocks. Again we remind you to use whatever works with your child.

Step Seven. Finish one step before proceeding to the next. If your child has forgotten a previous step, be sure to go over it again.

Remember: (1) Always make the sessions fun and pleasant.

(2) It is better to do the sessions a number of short periods, rather than one long time; it is hoped, however, that eventually these short periods of time can be stretched to periods of 15-20 minutes in length.

(3) Always let your child know he or she is doing a good job.

Glossary

Air Conduction Testing. The hearing testing which stimulates the ear with sound energy which is propagated through the air in the ear canal to the ear drum.

Ambient Noise. All the noise in a specific environment. As used in this guide, noise refers to all unwanted acoustic energy present in the hearing screening environment.

Attenuation. The reduction of energy (for example, sound energy or electrical energy). The attenuator of an audiometer reduces the electrical energy that is delivered to the audiometer earphones and, thereby controls the level of sound energy delivered to the external ear canal.

Audiologist. A professional trained to measure human auditory function and to provide and direct the auditory management services necessary for the successful use of residual hearing for learning, communication, and social/emotional well being. Audiologists must earn at least a master's degree in audiology from an approved university program, meet national testing and experience requirements, and in most states, meet requirements for state licensure.

Audiology. The profession concerned with measurement of auditory system function and nonsurgical, non-medical management of persons with auditory and communication impairments. Areas of study include the anatomy and physiology of the normal and pathological auditory system, acoustics and psychoacoustics, electronics, measurement of hearing and site of lesion testing, the effects of hearing loss on speech and language development, and the (re)habilitation of children and adults with hearing loss.

Audiometer. An instrument for determining the threshold of hearing. Audiometers employ a variety of acoustic test signals including pure tones and speech stimuli.

Bilateral Hearing Loss. A hearing loss in both ears.

Bone Conduction Testing. The hearing testing which stimulates the inner ear by conducting sound through the cranial bones.

Calibration. The process of checking and adjusting a quantitative measurement instrument to ensure that it meets standardized specifications. Audiometers must be calibrated to the standards of the American National Standards Institute.

Cerumen (ear wax). A yellowish waxy substance secreted by the external ear canal. Excess cerumen in the ear canal can result in conductive hearing loss.

Cognitive Disability. The significantly subaverage intellectual functioning during infancy and childhood which exists simultaneously with deficiencies in the adaptive skills needed to meet the demands and expectancies of the general society.

Conductive Hearing Loss. The hearing loss resulting from abnormalities of the external and/or middle ear.

Congenital. The conditions in infants that are present at or before birth.

daPa. The abbreviation for the term deca Pascal, which is the unit for air pressure used in tympanometric measures. The term honors Blaise Pascal, a French scientist. The daPa is approximately equal to one millimeter of water pressure, and 0 daPa on the tympanometric pressure scale equals normal atmospheric pressure.

Decibel (dB). A dimensionless unit for expressing the ratio between two sound pressures or two sound powers.

Down Syndrome. A collection of cognitive and physical disorders present at birth that are caused by a genetic disorder. Common characteristics include mental retardation, heart disease, slanting almond shaped eyes, broad nose bridge, protruding tongue, open mouth, small slightly flattened skull, small ears, and reduction of muscle tone.

Earphones. The devices worn over, on, or in the ear for presenting a sound stimulus to the ear.

Exceptional Educational Needs. The needs of children with mental, physical, emotional or learning disabilities which require special educational services to supplement or replace regular educational services.

Fluctuating Hearing Loss. The temporary, frequent changes in auditory sensitivity which occur as the result of ear disease. The most common cause of fluctuating hearing loss in children is middle ear dysfunction and liquid in the middle ear space.

Frequency is the physical unit which corresponds to the pitch of an acoustic signal. The frequency of a pure tone equals the number of sine waves cycles occurring within one second and can be expressed in cycles per second.

Hearing Impairment. All disorders of hearing regardless of their nature, cause, or severity, whether permanent or fluctuating, which impair one or more of the following: auditory language learning, auditory/verbal communication, academic performance, and social or emotional development.

Hearing Loss. A general term which refers to any diminution in normal auditory functioning including reduced hearing sensitivity and ability to understand speech. Normal auditory functioning is defined based on the measured auditory abilities of healthy young adults with negative histories for ear disease and damaging noise exposures. The presence of a hearing loss does not necessarily imply a hearing impairment.

HL (hearing level). The number of decibels above or below the average normal threshold for a specific sound at which an individual can just detect the presence of the signal about one-half of the time.

Hz (hertz). The universal symbol for the unit of frequency of a sound, named after the German physicist Heinrich Rudolph Hertz. One Hz = 1 cycle per second.

Masking. The audiometric procedure used to prevent or alter the detectability or identification of acoustic signals during hearing evaluations. Masking is often necessary to independently test each ear.

Middle Ear. The portion of the ear which includes the tympanic membrane (ear drum) and the air-filled cavity behind it which contains the three middle ear bones.

Neonatal. The newborn period.

Otoscope. A hand-held instrument for inspecting the external canal and tympanic membrane (TM). The otoscope illuminates the ear canal and permits an improved view of the canal and TM through a magnifying eyepiece.

Play Audiometry. A testing technique used for testing the hearing of young children who cannot be taught to respond to auditory stimulation directly with a motor response. In play audiometry, the child's response to sound is part of a game that is highly motivating for the child.

Pure Tone. A sound wave that has the same shape as a sine wave and consists of a single unvarying frequency.

Reliable. Tests that produce results that are reproducible when conducted over time.

Sensorinueral Hearing Loss. A loss of hearing sensitivity due to an impairment of the inner ear (cochlea) or the nerve pathways to the brain.

SPL (sound pressure level). The ratio, expressed in decibels, of the sound pressure of a particular acoustic signal to a standard reference pressure.

Threshold. The minimum effective sound pressure of an acoustic signal which is capable of evoking an auditory sensation about half the time.

Threshold Testing. The standardized procedure for determining a listeners threshold to pure tone or other acoustic stimuli.

Tympanometry. The measurement of changes in the compliance (flexibility) of the eardrum as air pressure is varied in the external ear canal.

Unilateral Hearing Loss. A hearing loss in only one ear.

Valid. The hearing screening tests that identify individuals as positive who have hearing sensitivity worse than the established criteria, and those as negative who have hearing sensitivity better than the established criteria.

Appendix E

Relevant Materials

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